TRI-K Industries, Inc.
The Cosmetic and Personal Care Innovators sm

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APPENDIX I.

IN VITRO SPF METHOD:

PROCEDURE, MATERIALS , INSTRUMENTATION

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IN VITRO SPF MATERIALS : TEST SUBSTRATE- VITRO-SKIN™

VITRO-SKIN ™ is an advanced testing substrate that effectively mimics the surface properties of human skin. It contains both optimized protein and lipid components and is designed to have topography, pH, critical surface tension and ionic strength similar to human skin. Testing done on VITRO-SKIN is generally more reproducible than that performed on human skin due to the consistent topography and wetting properties across each sheet. VITRO-SKIN is optimized to mimic human back skin.

VITRO-SKIN is prepared for use by hydrating in high humidity chamber overnight prior to product application.

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TRI-K *in vitro* SPF / UVA determination
Standard Operating Procedure # 1V

Instrumentation / equipment:

SPF-290 Analyzer (The Optometrics Group)
Wheaton 60 - 100 µl Micropipette
Wheaton 60 - 100 µl Capillary Tubes
Plastic hydration chamber with removable mesh shelf
Plastic covered foam block
Metal frame sample holder
Latex finger cots

Substrate: Vitro – skin ™ (IMS – Innovative Measurement Solutions Inc)

Method:

Part One - Setting up a hydration chamber for Vitro-skin™ hydration.

1. Prepare 200 grams of water / glycerin solution in 70% / 30% proportion (140 grams of water and 60 grams of glycerin).

2. Remove mesh shelf from the chamber and pour water / glycerin mixture into the bottom of the container.

3. Place the shelf back and replace the lid making sure it provides good seal.

Part Two - Preparation of the Vitro - skin™

1. Carefully open the individually packed sheet (22 cm x 27 cm) of Vitro - skin™.

2. Prepare 6.2 cm x 9.0 cm pieces of Vitro – skin™. One sheet yields approximately 10 test pieces. Nine pieces will be used for samples testing and the tenth one will serve as a reference.

3. Place the pieces on the mesh shelf of hydration chamber for at least 16 hours prior to product application and testing.

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Part Three – Product application and SPF / UVA PF Measurement

1. Turn on the SPF –290 Analyzer and allow it to on the warm up and stabilize for 15 – 20 minutes prior to calibration and optimization. Follow the SPF –290 Instruction Manual to properly operate the instrument.

2. Remove a piece of Vitro - skin™ (6.2 cm x 9.0 cm) from the hydration chamber and place it rough side up on the plastic covered foam block (used to simulate the flexibility of the human dermis). Product application must be made to the " skin topography " side of the Vitro - skin™.

3. Carefully draw 100µl of the test sample into micropipette. Make sure there are no air bubbles in the sample.

4. Apply 100µl of the product evenly in rows of small " dots " across a 6.2cm x 8.0 cm section of Vitro-skin™. This results in a product dose of 2µl / cm^2.

5. Rub the product into the Vitro-skin™ with a gloved finger as you would on human skin in vivo. Initially do it with circular motion and finish it with " back & forth " motion.

6. Place the skin sample on the metal holder. Attach the corners of the skin to the frame of the holder with the tape (transpore tape can be used) that holds the sample for duration of the test.

7. Allow the sample to dry for 15 minutes.

8. Remove the reference piece of Vitro-skin™ from hydration chamber and attach it to another sample holder. Let it dry for 15 minutes as well.

9. Test the product following the **Instruction # 1**. Do a minimum 6 runs, preferably 12.

10. It is recommended to do the test in duplicates.

11. Average the results. Standard deviation of each result should not exceed 20%.

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SPF *IN VITRO* TEST METHOD using THE OPTOMETRICS MODEL SPF-290 ANALYZER

Instruction # 1

1. Turn on the instrument and click on **Win SPF** icon.

2. Login operator name and click **OK.**

3. Go to **Setup** and click **to load setup file**
   - Click on autoscan.par

4. Go to **Samples**

5. Click **Initialize**
   - SPF initialization, stage initialization, monochromator initialization

6. Load blank substrate and click **OK**

Signal level set (adjust SPF High Voltage and Gain until Signal is in Green Region) and click **OK**

7. Go to **Sample ID** and click on.
   - Enter sample ID, identify the substrate and click **Reference Scan.**
   - Load blank substrate and click **OK**

8. Prepare the test sample.

9. Click **Scan,** load sample holder and click **OK**. Sample is being tested (MPF scan). Instrument will do automatically 6 scans. Additional 6 scans may be added by clicking **add** and typing 6.

10. Click on **SPF** to see SPF data

11. Click on **Reports,** then on **Print Graph** to obtain printed graph.

12. Click on **Next – Save - OK** to save data before next run.

Version

THE OPTOMETRICS GROUP

Optometrics USA, Inc

SPF Analyzer Software for Windows®

WinSPF

SPF Analyzer Software for Windows

Users Manual

Nemco Way • Ayer, MA 01432
Phone 978-772-1700 • Fax 978-772-0017
www.optometrics.com

9/99

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Introduction

Overview of the Instrument

The Optometrics Model SPF-290 Analyzer is a computer controlled instrument that is designed to measure the sunscreen protection factor (SPF) of sunscreen preparations. The protection factor is calculated over the wavelength range from 290 to 400 nm. The instrument includes a UV-VIS source, a grating Monochromator and a detector to measure the transmittance of a sample that is spread on a piece of Transpore™ tape or other medium. A detailed technical description of the instrument is presented in Chapter 2: Principles of Operations: Optical System.

The instrument is available in two formats:

- a manual instrument, in which the operator positions the sample between each scan (e.g. without the X-Y sample stage)
- a system with an automated X-Y sample stage. The sample stage allows for automated measurement of different regions of the sample.

When the system is equipped with the automated sample stage, three "general" modes are available:

- **Auto-Scan mode** - used when the operator wishes to measure the SPF at several sample positions on an automated basis,
- **Time Based mode** - used when the operator wishes to measure the SPF of a sample as a function of time (Kinetics), and
- **Assay mode** - used when the operator wishes to check the consistency of a product within the same batch or from one batch to another.

Optometrics provides a standard set-up format for each mode, which should meet the needs of many laboratories. Additionally, a set of default setup parameters is used while creating new setup files. The parameters can be edited as required to meet the specific needs of the laboratory

System Components

The SPF-290 is not a stand-alone system. A computer must be added to it in order to provide instructions, control the hardware, perform calculations, and present results. The user inputs instructions using either the computer's keyboard or mouse as prompted by instructions on the computer's display. Once the measurement data are collected and reduced to measurement

results, data are presented on the computer's display in tabular and graphical form.

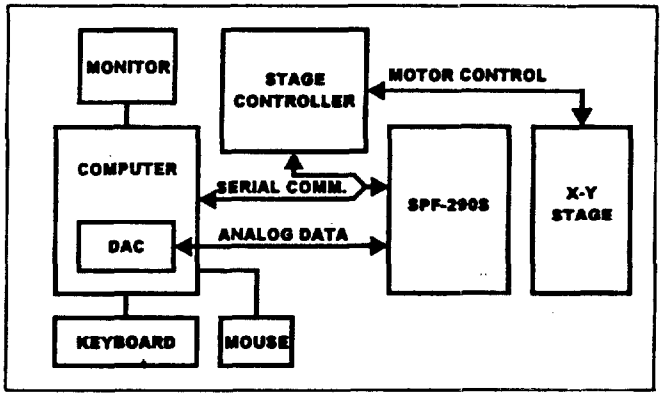


Figure 1 – Basic System Set-up

The computer must contain a data acquisition circuit board to provide interface between the SPF-290 and the computer. The DAC (Data Acquisition Card) converts analog voltage output by the SPF-290 into a digital representation of the voltage and can communicate the digital value to the computer for further operations.

Additional I/O (input and output) is provided through one of the computer's serial ports.
If the SPF-290 is equipped with an x-y sample stage, a stage controller is required. The controller is used to communicate with the SPF-290 computer via a serial port, provide power for the interface electronics, house the x-y stage's stepper motor controllers, and output the drive signals for the stage motors.

Other required components include a sample holder for manual or stage use, interconnecting cables, and the WinSPF software

Principles of Operation

The SPF-290 consists of the Analyzer, a data acquisition system, a PC and display monitor, and optionally, an X-Y sample stage and controller. The SPF-290 system uses a variety of technologies to provide optimal measurements that reliably predict *in vivo* test results. The components are packaged to provide flexibility and convenience in a laboratory environment.

The SPF-290 Analyzer unit houses an optical system to pass illumination through the sample and measure its monochromatic transmission relative to a blank sample substrate. Prior to actual measurements the system performs an automatic initialization to establish various operating parameters. Once initialization is concluded the system throughput is optimized to provide maximum signal-to-noise operation.

The sample analysis is then conducted using manual sample manipulation or an automatic X-Y sample stage for sample positioning.

X-Y Stage Sampling Grid

The X-Y sampling stage can be used to collect data for up to twelve samples on a single piece of Transpore ™ tape. In this mode of operation, the stage is driven to various stage locations for measurement scans.

Three stage modes are available:

- Fixed Grid
- Random Grid
- User Specified Grid

Optical System

The optical system of the SPF-290 Analyzer is comprised of a continuous UV-VIS source, color compensating filters, integrating sphere, a grating Monochromator and a detector.

Ultra-violet (UVB) and near ultra-violet (UVA) radiation is provided by a compact, 125W xenon arc lamp. The lamp has a single sapphire window for enhanced UV transmission and an internal parabolic reflector. It is surrounded by an efficient heat sink and cooled by a fan on top of the lamp housing. The lamp is positioned vertically to minimize the effect of arc wander and obviate

the need for beam steering mirrors.

Partially collimated radiation from the source passes through a wire attenuator, filter and aperture before striking the sample. The filter attenuates the source radiation above 500 nm, altering its spectral distribution so that it approximates the solar irradiance spectrum. The beam of ultraviolet radiation incident on the sample is transmitted, absorbed or reflected by the sample and substrate. Transmitted radiation is collected by an integrating sphere and enters a compact, in-line Fastie-Ebert grating Monochromator with a 2400 g/mm replicated holographic grating optimized for UV efficiency.

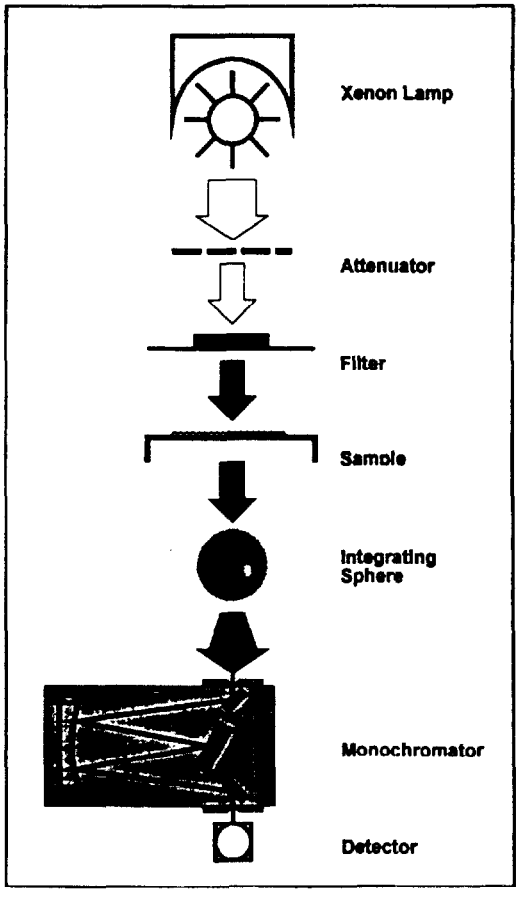


Figure 2 – Optical Set-up

Integrating Sphere

The integrating sphere collects transmitted scattered light from the sample. The output of the

integrating sphere passes into the Monochromator where it is separated into discreet wavelength bands. Figure 3 shows a sectioned view of the integrating sphere and possible light ray paths.

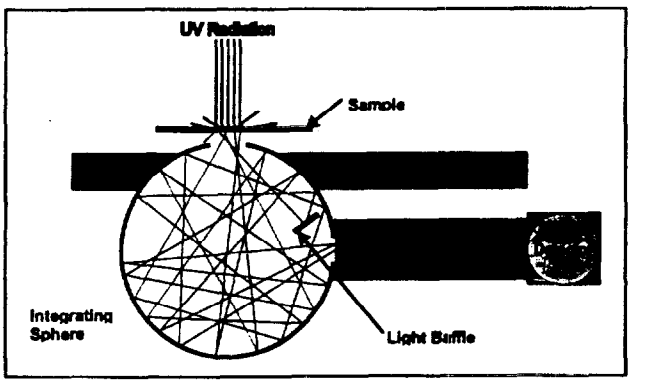


Figure 3 – Integrating Sphere

The monochromatic radiation exiting the Monochromator has a spectral resolution of 1.7 nm. The radiation impinges on the photosensitive surface of the detector and generates a signal proportional to the intensity of the radiation striking the detector surface.

System Layout

A single switch on the analyzer turns on the source electronics and computer. A time delay relay protects the computer from the electromagnetic surge (≈ 20,000 V) generated by the xenon source high voltage starting pulse. Figure 4 below presents an overview of the optical path, power line and signal connections within the system.

Data Acquisition Card

The Data Acquisition Card (DAC) is used to convert analog voltage readings from the SPF-290 detector/amplifier into a data format that can be read by a computer. There are two models of DACs used in the SPF-290. Older units are equipped with a *Keithley Instruments* DAS-8/PGA-G2. Newer SPFs may be equipped with a *Keithley Instruments* DAS-802 board.

Both boards have similar basic features with the DAS-802 being of newer design and having additional features not required for the SPF-290. The DAS-8/PGA-G2 is of older design and expected to be out of production in the near future.

As used with WinSPF, the DAS-8/PGA-G2 can operate under Windows '95 and '98. However, the DAS-802 can operate under Windows '95, '98 and NT 4.0.

The DACs use a 12-bit, successive approximation analog-to-digital converter (often referred to as A/D, A-D or ADC) with an integral sample and hold circuit. The A-D provides 12-bit resolution with ±1 least significant bit (LSB) accuracy. With 12-bit conversion the maximum reading is 4096 counts. With an accuracy of ±1 LSB this means a reading of 4000 counts will yield an accuracy of ±1/4000 or ±0.025%. With a reading of 200 counts the accuracy is ±1/200 or ±0.50%.

The maximum conversion time, the time from the beginning to end of the conversion from an analog-to-digital value, is ≈35 μs. Both boards have on-board timers allowing the software to make conversions at intervals exceeding the 35 μs conversion time. Although the boards have several timers that can be cascaded to permit very long conversion intervals, the SPF-290 uses just the master clock, which yields a maximum timing interval of 65 ms. **Note:** the 35 μs conversion time and the timing interval are independent of one another. It takes 35 μs to make a conversion regardless of the interval between conversions. Thus, there is little advantage to using long reading intervals for SPF measurements.

The DACs allow the software to adjust their gain, providing optimum resolution for low-level signals. Conversely, the gain is reduced if the input signal is so large that it saturates the A-D converter (>4096 counts). The gains are 1, 2, 4 and 8 yielding a full-scale range of 10, 5, 2.5 and 1.25 volts respectively. As each reading is taken, WinSPF checks the reading against maximum and minimum limits. If the reading is below the minimum (1,000 counts) the gain is

increased. The cycle is repeated until the reading is above 1,000 counts or the maximum gain is invoked. Conversely, when a reading is >4,000 counts the software reduces the gain in like manner.

As each A-D conversion is completed, the results are stored in the DAC buffer. Once all the conversions have been acquired (i.e.: the number of required readings has been achieved, as defined in the setup parameters) and the buffer is full, WinSPF reads the buffer contents and processes the readings.

The DACs must be configured using switches and jumpers prior to installation. WinSPF must also be configured to communicate with the DAC during installation or using hardware setup.

Analysis

During an analysis, the computer transmits commands to the controller via the RS-232 port (COM1 or COM2), instructing the controller (and hence the Monochromator) what wavelength to go to and how long to dwell at that wavelength. The signal is sampled a predetermined number of times during the dwell period, averaged and stored as a data point corresponding to a specific wavelength (5 nm above the previous wavelength). After the data point is stored, the process repeats at the next wavelength. The software checks that the monchromator has reached the next wavelength and its motor has stopped. It then instructs the A-D board to commence conversions, ensuring that ORDINATE data from the detector is correlated with ABSCISSA data (wavelength) from the controller. The process is repeated 23 times at 5 nm intervals from 290 to 400 nm.

To initiate an analysis, a reference scan (which consists of data from the 23 wavelengths) is made with the blank substrate in the incident beam. Sample is then applied to the substrate and the first sample scan is made. Data is collected in the same manner as the reference data, ratioed to the reference and plotted as a MPF (Monochromatic protection factor). Ratioing the sample signal to the reference signal negates any effect of wavelength dependent variables in the optical system (source, Monochromator and detector). Up to 12 sample scans can be made to compensate for variables in the substrate and sample application.

SPF-290 Specifications

Source:
- Lamp.....Xenon CW
- Power.....125 W (operated at 75W)
- Spectral Range.....200 nm to 1.7 µ

Source Power Supply:
- Output (starting).....20,000 V
- Line Regulation.....<1%
- Load Regulation.....<1%
- Ripple.....1mV RMS max

Detector:
- Type.....Multialkali side-on PMT
- Spectral Range.....185-850 nm
- Peak Response.....530 nm

Gross Weight.....25 Kg (55 lbs)
Weight .....19 Kg (40 lbs)

Monochromator:
- f number.....3.9
- Focal Length.....74 mm
- Grating.....2400g/mm, holographic UV optimized
- Resolution.....1.66 nm with 300 µ slit
- Wavelength Accuracy.....± 0.2%
- Spectral Range.....200 to 650 nm
- Wavelength Reproducibility.....0.25 nm
- Wavelength Selectability.....0.125 nm

Data Files (typical):
- SPF Data File.....16K
- ASCII Data File.....36K
- ASCII Summary Data File.....2K

Dimensions.....43 x 32 x 25 cm

System Spectral Range....290 nm to 400 nm

The SPF-290 Recording Spectrometer includes the following:

- The SPF-290 Analyzer,
- Three sample holders,
- X-Y stage (optional),
- X-Y stage stepping motor controller (optional),
- Data acquisition board,
- I/O, RS-232 and power cables,
- WinSPF software program diskettes (three 3.5" diskettes),
- DriverLINX DAS board drivers (either CD or floppy versions available),
- One (1) Box of Transpore™ Tape (8-5010),
- One (1) Box Syringes (8-5015),
- Two ND calibration filters (1.0 and 1.5 D), and
- WinSPF Users Manual.

Transpore™ is a trademark of the 3M Corporation.

System and Software Installation

Operating and Safety Precautions

The Optometrics SPF-290 Analyzer is a high performance system that determines the sunscreen protection factor of samples using a continuous UV-VIS source, a color compensating filter, an integrating sphere, a grating Monochromator and a detector.

The following precautions should be followed to optimize the performance of the system and minimize the possibility of personal injury or damage to property when using the instrument.

- The analyzer must be plugged into a grounded power line. Ensure that the system is properly grounded. It is strongly recommended that all parts of the system be plugged into a common ground.

- Do not look directly at the Xenon lamp when it is lit. The xenon lamp produces ultraviolet radiation that can cause eye damage.

- Do not attempt to disassemble the analyzer. With the exception of the lamp, there are no customer serviceable parts inside the analyzer. Any attempt to disassemble the analyzer may expose the user to high voltage shock hazard, alter the optical or mechanical alignment and will void the warranty.

- Allow the instrument to warm up for 15-20 minutes prior to initialization. The optimum performance of the lamp and other components of the system are observed after a short warm-up period.

- Make certain that the cooling fans on top of the lamp housing and the lamp power supply are operating. If either fan is inoperative, turn off the power switch immediately.

- Use in a well ventilated area. The UV lamp generates a small amount of ozone.

Unpacking the Unit

The SPF-290 Analyzer is shipped in a single container that includes the following:

- The Analyzer Unit

- A software package, which includes a data acquisition board and several program diskettes (3.5") and possibly a CD-ROM
- A cable package, which includes an I/O cable, power line cord, power line cord (computer) and RS-232 cables
- A hardware/assembly package, which includes three sample holders, a box of Transpore™ tape, a box of 1 cc syringes and two Neutral Density calibration filters (1.0 and 1.5 D)

If the instrument is ordered with the X-Y sampling stage accessory; the X-Y auto sampling stage, electronic control unit, and a split RS-232 cable are also included.

If you purchased your SPF-290S complete with a computer system, the computer system and monitor will be shipped in their own container(s).

Carefully inspect all shipping cartons and all components. A packing list is provided for verifying all items that have been included. If any damage is observed or any components are missing, contact the shipping agent and Optometrics immediately.

If there is any evidence that the instrument is damaged, do not plug it into the power line, contact Optometrics or your local agent.

It is recommended that the shipping cartons be retained because they can be used if it should become necessary to transport the system.
Note: The input voltage for the analyzer unit is set at the factory to correspond to the location to which the unit is shipped. If it is necessary to change the voltage, refer to the section on Electrical Input Voltage (chapter 2)

Data Acquisition Board Installation

Installing the DAC (Data Acquisition Card) in the SPF-290 computer is a three-step process. The first step is to configure the board to communicate with the computer. The second is to physically install the board in the computer. The final step is to instruct WinSPF and the Windows operating system on the board configuration. The latter step is dependent on which of two boards are installed and which Windows operating system is being used.
WARNING: Turn off power to the computer before installing the data acquisition board.

- Remove the cover from the computer and make certain that the frame is properly grounded.
- Remove the protective cover for a card slot on the back of your computer (any ISA card slot

can be used).

- Remove the data acquisition board from its protective package. The DIP switches on the board are set at the factory for the default configuration. Refer to Data Acquisition Board Setup for details on board configuration for the SPF-290.
- Align the data acquisition board with the expansion slot and gently press the card into the free slot.
- Fasten the card in the expansion slot with the screw that held card slot cover.
- Replace the cover of your computer.

Data Acquisition Board Settings

The data acquisition board (DAC) must be configured to operate with other hardware in the SPF-290 computer and with WinSPF. The SPF-290 computer must know where to send board instructions and where to get data. An interrupt may also be used to tell the computer when a board operation is complete. Additionally, the DAC can be configured for single-ended or differential input. Thus, before the DAC can be used with WinSPF the board must be configured by setting a series of switches and jumpers.

The first step is to set the base location in memory where instructions and data can be exchanged. The base memory address is determined by setting seven switches on the board. The default memory address for WinSPF and the DAS-8/PGA-G2 and DAS-802 data acquisition boards is 300H (H stands for hexadecimal). Other possible locations are 320H, 340H, 360H, 380H, 3A0H, 3C0H, and 3E0H should 300H produce a conflict with other hardware.

For the DAS-8 the address is set on the switch block labeled "BASE ADDRESS". As shown in figure 5 the switch is set for the default address of 300H. For other addresses change the individual switches to conform to the following table.

Note: For a complete reference, the following table shows the address in hexadecimal (H), truncated binary and decimal. Binary numbers are represented by 1 and 0, 1 representing 'on' or upper position, 0 representing 'off' or lower position.

Hex	Binary (lower 3 bits not used)	Decimal
300	1100000	768
320	1100100	800
340	1101000	832
360	1101100	864

380	1110000	896
3A0	1110100	928
3C0	1111000	960
3E0	1111100	992

Figure 5 - DAS-8 BASE ADDRESS

On the DAS-8/PGA-G2 DAC S2 is used to set the inputs as differential or single ended. The SPF-290 uses a single-ended input. Thus, switch # 1, which corresponds to channel 0, must be set ***on*** or in the up position. The DAC has 7 more available inputs, which are not used for the SPF-290. Therefore, their corresponding switch settings are irrelevant.

The final setting is the interrupt level, labeled "IRQ LEVEL". The jumper must be in the position for which the DriverLINX driver is configured, shorting the two terminals as shown in the diagrams at the corresponding number.

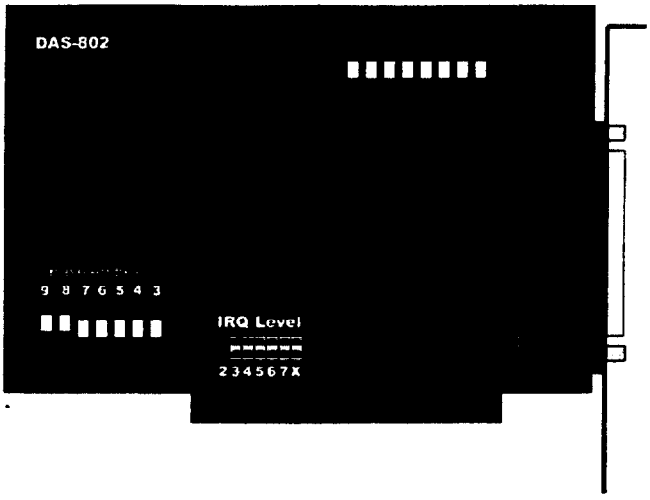


Figure 6 - DAS-802 board

The DAS-802 board is smaller than the DAS-8/PGA-G2 board. However, its switch and jumper locations are very similar to those of the DAS-8. All settings are common to both.

Electrical Input Voltage

The input power module is located on the rear of the SPF-290 and is a multi-function module containing the system on-off switch, an IEC 320 receptacle for the line power cord and a two-position voltage selector. The input voltage selection is set at the factory for the location to which the system is being shipped. It should not be necessary to change the setting unless the system is relocated. Figure 7 can be used to verify the correct setting before use.

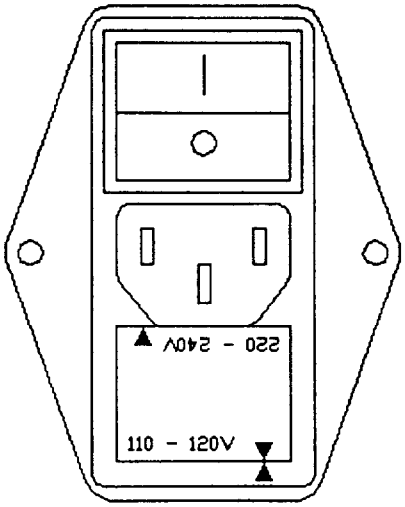


Figure 7

For 110 - 120 volt operation the white triangular symbol on the fuse carrier adjacent to the 110 - 120V notation must be positioned so that it points to the triangular symbol on the power module as shown.

For 220 - 240 volt operations the white triangular symbol adjacent to the 220 - 240V notation must align with the symbol on the power module.

To change the voltage selection, pry out the fuse carrier with a straight screwdriver, rotate the fuse carrier 180 degrees and re-insert it in the module.

SPF-290 Computer

If you have purchased your SPF-290 from Optometrics complete with a computer system, it will, as a minimum, have a 200 MHz MMX processor, 32 MB RAM, a 24X CD-ROM, a 2 GB hard drive, keyboard, 14" color monitor, mouse and Microsoft Windows 95® or 98® installed.

If you have not purchased your SPF-290 from Optometrics complete with a computer system, the system requires a personal computer with the following minimum specifications:

- Pentium Microprocessor with numerical coprocessor,
- 16 meg RAM,
- VGA color graphics card and display,
- an ISA PC-XT expansion slot,
- a parallel printer port,
- Serial communication port (RS-232), COM 1 or COM 2, and
- Windows'95, '98, or NT 4.
- SPF-290 Printer

The SPF-290 is not supplied with a printer. WinSPF uses the default Windows printer for all printed reports. The printer must have graphics capability to print the report forms.

SPF-290 X-Y Stage

The following describes the installation of the SPF-290 sample stage. Note: The X-Y Sampling

Stage may have been installed at the factory. If it has been installed, go directly to X-Y Stage Cable Connections.

Caution: Take care to ensure that the optical sensor at the rear of the stage is not damaged during this installation.

- Loosen the left and right side cover screws on the stage (3 on each side).
- Remove the left and right side covers from the stage.
- Remove the two (2) large flat head screws on the front of the platform base of the SPF analyzer unit.
- Place the X-Y Sampling Stage on the analyzer platform base plate and align the attachment screw holes.
- Use the screws provided with the X-Y Sampling Stage to attach the stage to the analyzer unit. It may be necessary to manually move the stage to access the screw holes.
- Reinstall the two side covers on the stage and tighten the screws.

X-Y Stage Cable Connections

Refer to Figure 8 for the correct cable connections between various components in the SPF-290 system.

Connect the auxiliary power cord (p/n 451-0016) as follows:

- Insert the male plug to the power receptacle on the rear of the X-Y motor controller.
- Insert the female plug into the receptacle marked AUX on the rear of the analyzer unit.

Connect the I/O cable (p/n 6066-0037) as follows:

- Insert the 9-pin plug into the receptacle marked I/O on the rear of the analyzer unit.
- Insert the 37-pin connector into the socket on the data acquisition board (on rear of computer).

Connect the split RS-232 cable as follows:

- Insert the 25-pin male end to the port labeled RS-232 on the back of the analyzer.
- Insert the 9-pin male connector into the back of the X-Y stage motor controller.
- Insert the 9-pin female end to the COM1 or COM2 port of the computer. If your SPF-290 was delivered complete with a computer system, insert the 9-pin female end into the port on the rear of the computer marked "RS-232".

Connect one end of the X-Y motor control cable into the back of the X-Y motor controller. Plug the other end into the X-Y sampling stage.

Connect the line power cable (p/n 451-0014 [110 V], p/n 451-0013 [230 V]) as follows:

- Insert the female end into the receptacle marked AC on the analyzer unit.
- Insert the male end into the line (mains) outlet.

Connect the printer cable to the printer port on the computer (LPT1 or LPT2) and plug the power cable to the line (mains) outlet.

Cable Connections (no stage)

Connect the I/O cable (p/n 6066-0037) as follows:

- Insert the 9 pin plug into the receptacle marked I/O on the rear of the analyzer unit.
- Insert the 37 pin connector into the socket on the data acquisition board (on rear of computer).

Connect the RS-232 cable (p/n 451-0019) as follows:

- Insert the 25 pin male end into the RS-232 receptacle on the back of the analyzer unit.
- Insert the 9 pin female end into the COM1 or COM 2 port on the computer. If your SPF-290 was delivered complete with a computer system, insert the female end into the port on the rear of the computer marked "RS-232".

Note: COM1 is the communications port for the SPF-290 selected via the default parameters. If COM1 is assigned to another component in the computer, refer to hardware setup to select the COM port from the software.

Make certain that the analyzer power switch is turned to OFF before continuing.

Connect the line power cable (p/n 451-0014 [110 V], p/n 451-0013 [230 V]) as follows:

- Insert the female-pin end into the receptacle marked AC on the analyzer unit.
- Insert the male-pin end into the line (mains) outlet.

Connect the printer cable to the printer port on the computer (LPT1 or LPT2) and plug the printer power cable to the line (mains) outlet.

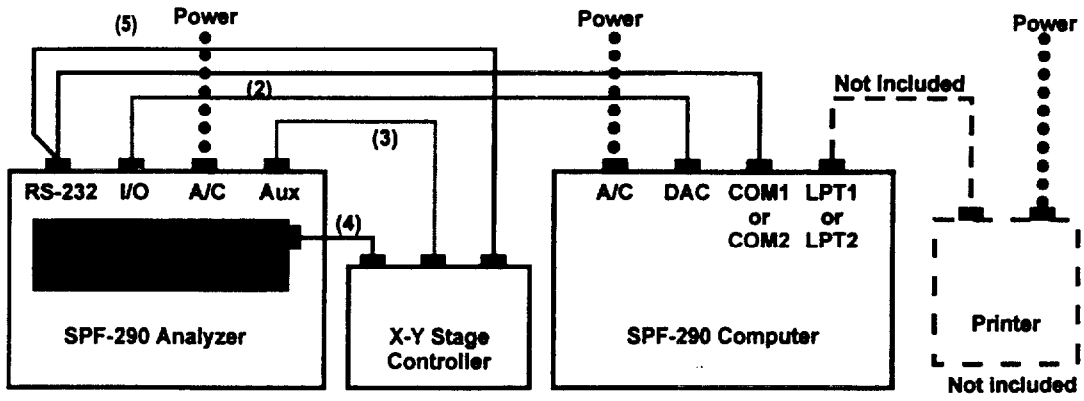


Figure 8 – Cable Connections

(1) RS-232 Cable (25-pin male to 9-pin female, extra)

(2) I/O Cable (9-pin male to 37-pin female)

(3) Auxiliary Power Cable

(4) X-Y Control Cable (15-pin male to 15-pin female)

(5) RS-232 Cable (split, 25-pin male to 9-pin female & 9-pin male)

Software Installation

The software installation is a two-step process. The first step is to install the data acquisition board driver followed by installing WinSPF.

The data acquisition board driver installation differs depending on which of two data acquisition boards are installed in the SPF-290 computer. Additionally, the installations differ for Windows '95, '98 and Windows NT. The following sections describe the procedures for each board and operating system.

DAS-8/PGA-G2

If you are using a DAS-8/PGA-G2 data acquisition board you may have received a white software envelope with a Scientific Software Tools, Inc. label or a Keithley Instruments CD-ROM. The DriverLINX drivers are supplied on either floppy diskettes or a CD-ROM. The following sections describe the procedures for the two types of media.

Floppy Disks

The envelope described above should have an adhesive label stating "WIN95/VB". The envelope will include at least 4 diskettes and may include a total of 6. The two diskettes labeled "Documentation" should be put aside because they are not needed. The four remaining diskettes should be labeled "DriverLINX/VB 4.0 for Windows 95, Keithley Metrabyte DAS-8". If this is not the case, contact Optometrics and do not install any software from the disks in the envelope. It will only create more work because you must uninstall the incorrect driver before installing the correct one.

To install the driver place the diskette labeled "Disk 1 of 4" in the computer's floppy drive. From Windows select **Start**, **Run** and enter **a:\setup** in the form or choose **Add/Remove Programs** from Windows **Control Panel**. A Welcome message appears: select **Next** at the bottom of the form. The next screen shows the DriverLINX license agreement. Be sure to read the agreement carefully before agreeing so that you understand your rights and responsibilities.

After accepting the license agreement the **Registration** form is displayed. Fill in the fields as required. Next, the **Select Setup Type** form is displayed. Because we are installing only a portion of the DriverLINX tools, select **Custom**. Accept the default directory unless you know it will cause a problem in your system.

Of the choices listed under **Custom Installation**, uncheck all but **DriverLINX drivers**. Select **Next** and follow the on-screen instructions. At some time in the installation a message is displayed to the affect that the setup process will upgrade some files and asking for approval. Select **OK**. Near the conclusion of the installation the following message is displayed:

LoadLibrary("c:\windows\system\dlxocx16.ocx") failed error

Please ignore this error. Everything but a 16-bit ActiveX control is correctly installed and the ActiveX control is not needed for Windows 95 or 98. Another message is then displayed asking if the user wishes to see **What's New** in this version of the driver. This contains technical information that is of little use to the SPF-290 user. Finally, the instruction to restart your computer is displayed. It is safest to restart your computer before installing WinSPF although restarting later should not cause a problem either.

The only step remaining for the driver installation is to configure the driver for the data acquisition board installed in the computer. This will be done as WinSPF is installed.

CD-ROM

Upon opening the white envelope described above you will find a CD-ROM labeled Keithley, DriverLINX for Windows 95/98, DAS-8 Series. If this is not the case contact Optometrics without first installing the contents of the CD-ROM.

Fill out the registration card and return it to SST. Insert the CD in your CD drive. If your computer has auto start the CD-ROM installation will begin automatically. If not, choose **Add/Remove Programs** from the **Control Panel** using either **My Computer** or the **Setting** option from the **Start** command.

The Keithley opening banner is displayed and will be replaced by a menu select display. Select **Install DriverLINX** followed by **Install Drivers** and finally **Install DriverLINX/VB** on successive windows. A **Welcome** screen is then displayed and must contain the following statement: "DriverLINX for Keithley DAS-8 Series Visual Basic Custom Control and ActiveX Control version." If the statement does not agree, exit the installation and contact Optometrics for instructions.

Assuming the welcome message is correct, select **Finish** to complete the installation. The installation copies files to temporary locations on your hard disk. When the copying operation is complete, a blue screen is displayed with the heading "DriverLINX 4.0 for Windows 95" with the SST logo in the upper right corner. A welcome screen is displayed advising you to close all Windows applications. This is very important to a successful installation. Select **Next** which will display the license agreement that should be reviewed so that you know your rights and restrictions in the use of the drivers. Select **Yes** if you agree.

This will open a registration form in which you should enter your name, your company's name and the serial number from the envelope or registration card. Select **Next** to close the form and display the registration confirmation form. Selecting **Yes** will continue the installation.

The **Select Setup Type** screen is displayed at which the **Custom** option should be checked. Use the default directory unless this might cause problems with a previously installed DriverLINX driver.

Selecting **Next** will open a list of DriverLINX tools. Deselect all but **DriverLINX Drivers** by clicking on **DriverLINX API**, **DriverLINX Example Applications**, **DriverLINX Example Source Code** and **DriverLINX Help Files**. Thus, **DriverLINX Drivers** will be the only remaining choice that is checked.

Selecting **Next** will continue the installation procedure with a notice about upgrading some files. Select **OK** at which time more files are copied to their final destination.

Near the conclusion of the installation the following message is displayed:

LoadLibrary("c:\windows\system\dlxocx16.ocx") failed error

Please ignore this error by selecting **OK**. Everything but a 16-bit ActiveX control is correctly installed and the ActiveX control is not needed for Windows 95 or 98.

At the Finish Setup screen select **Yes**. In the following screen deselect "Yes, I want to see What's New" and select **Finish**. Then select **Yes** to reboot the system.

The driver installation is now complete. However, the driver must still be configured for the DAS-8 board installed in your computer. This is done during the WinSPF installation. However, the DriverLINX installation provides another method of configuring the driver by deploying an installation wizard the next time the computer is started. The wizard can be removed by clicking all the control commands at the bottom of the wizard without actually performing any of the tasks described.

If after WinSPF is installed you receive a "Driver not installed" error message, proceed with the following instructions. They are a duplicate of the instructions included in the DriverLINX Installation Wizard.

Open the DriverLINX folder from the Windows **Start** button and select **Learn DriverLINX 32**. This will display an Open DriverLINX DLL dialog. From the list of drivers select **kmbdas8.dll** and select **Ok**. An About DriverLINX dialog window will be displayed at which **OK** will close the window. You can now click **Continue** in the Wizard to follow the instruction further.

This will display a DriverLINX learning tool interface of an oscilloscope program. In the upper

left corner of the window select **Device** and choose **Select** from the menu. In the following window the default selection should be **Logical Device = 0**. If not, change the selection and select **Ok**. Select **Device** again and choose **Configure** from the menu. This opens a Device Configuration window. Select the Keithley model **DAS-8PGA** from the list. Choose the default address of **768** even if this does not agree with your board address. The correct address will be chosen during WinSPF installation.

In the **Section** frame choose **Analog**. Then in the **Analog Section** be sure that **Interrupt** is set to **None**. Now, select **Continue** in the Wizard to keep in step and then close the Oscilloscope application. Select **Finished** and then restart your computer. The driver installation and configuration is now complete.

DAS-802

If you are installing WinSPF on a computer with Windows NT, you must use the DAS-802 data acquisition board and software driver. The driver is included on a CD-ROM with the SPF-290. The CD is labeled **Keithley, DriverLINX for Windows 95/98 and Windows NT, DAS-800 Series**. If your CD label is different, call Optometrics before proceeding with the installation. As noted, the driver and DAS-802 can be used for Windows '9x. Therefore, three sets of instructions are included, for Windows '95, '98 and Windows NT.

Windows '95 Installation

To install the DAS-802 driver insert the CD in your computer's CD drive. The CD should automatically start. If not, use **Add/Remove Programs** from the Windows **Control Panel**.

From the **DriverLINX CD Browser Map** select **Install DriverLINX**. From **Install These DriverLINX Components** select **Install Drivers**. A welcome message is then displayed urging the user to close any open applications. Unless you have open applications select **Next**. The window that appears contains the license agreement for the DriveLINX driver. Be sure to read it to understand your rights and responsibilities. Once you accept the agreement select **Yes**.

Fill in the registration information in the following window. Note that this registration is independent of the WinSPF registration. The serial number used will be that on the envelope or registration card the CD came with. The next window shows the default program folder where

the drivers will be installed. Unless you know of possible conflicts, select **Next** to continue the installation.

The installation program then copies files from the CD to your hard disk and registers the files with the operating system. After these operations are complete, exit the installation program using the **Exit** button and then select **Done** to close the driver installation program. At this time, restart your computer so all the registration data can take affect.

When the computer reboots and after Windows is loaded a **DriverLINX Plug and Play Wizard** is displayed. This tool is used to guide you through the somewhat complex hardware installation and driver configuration process. A word of caution: The DriverLINX Wizard uses Windows' hardware installation user interface. However, Windows may have some different recommendations than DriverLINX. Be sure to follow the directions in the DriverLINX Wizard, which are duplicated here. Failure to do so may cause installation problems.

Select the **Wizard** button at the bottom of the **DriverLINX Installation Wizard**. The Windows **New Hardware Wizard** form is displayed with a descriptive message. Select **Next**. In the next form select the **No** option to the questions "Do you want Windows to search for your new hardware?" even though Windows recommends it. Then select **Next** to continue.

In the next form, labeled **Hardware Types**, select **DriverLINX Drivers** and click **Next**. Now, jumping back to the **DriverLINX Wizard**, click the **DriverLINX** button to open a new page of instructions. Then, moving back to the **Hardware Installation** window select **Keithley DAS-802 Analog Input Board** from the list of boards and then select **Next**.

The Windows hardware installation will then search through its resources to find some spare capacity where the board can be installed. It then displays the resources that it will use. Unfortunately, these settings have nothing to do with whether or not the board is capable of being installed at this location. In fact, the chosen resources are nowhere near the address space that the board is capable of. Therefore, we will change the settings later.

Switching back to the **DriverLINX Wizard**, select **Continue** for more instructions. Click **Finish** in the **Add New Hardware Wizard** window. This will prompt a few messages urging you to restart your computer. Choose **No** each time. We will restart the computer later when the total configuration is complete.

Back in the **DriverLINX Wizard**, select the **Device Manager** button. This opens the **System Properties** window. Select the **Device Manager** tab if it is not selected for you. The tree under **DriverLINX Drivers** should be expanded to show the **Keithley DAS-802 Analog Input Board** listing. Highlight the selection, select the **Properties** tab and then select the **Resources** tab. Highlight the **Input/Output Range** and select **Change Setting**. Use the arrow buttons next to the **Value** box to scroll through possible addresses. Select a valid address for the DAS board from the list in this manual. See chapter 3, data acquisition board settings. Note: the address is in hexadecimal notation. After selecting an address review the **Conflict Information** box to be sure it shows "No devices are conflicting." If this is not the case, select another address until one matches the manual list and shows no conflict. Then check the interrupt request and be sure there is no conflict. Write down the interrupt so the board can be correctly configured. Select **OK** to complete your selections. Windows will want to restart the computer again but select **No**. Close the **System Properties** window, return to the **DriverLINX Wizard** and choose **Continue**.

This action opens the **DriverLINX Configuration Panel**. Select the **Keithley DAS-802 Analog Input Board** from the list and select the **Configure** command button. In the **Logical Device Number** window enter 0 (zero) and then select the command button **OK**. Select **OK** in the **Configure DriverLINX Device** window, select **Close** in the **DriverLINX Configuration Panel**, and select **Finish** in the **DriverLINX Wizard**.
Now you **MUST** restart your computer for the new hardware and driver settings to take affect.

If at a later time it is necessary to make changes to the DriverLINX configuration, select **DriverLINX Configuration** in the Windows **Control Panel**. This will open the form we have just described enabling you to make the appropriate changes.

Windows '98 Installation

Because Windows '98 has automatic new hardware detection, do not install the DAS-802 board before installing DriverLINX drivers. Otherwise you will be faced with closing all sorts of unused forms and message boxes. The installation is very similar to that for Windows '95 but with a few minor differences. Thus, we repeat all the duplicate steps.

To install the DAS-802 driver insert the CD in your computer's CD drive. The CD should

automatically start. If not, use **Add/Remove Programs** from the Windows **Control Panel**.

From the **DriverLINX CD Browser Map** select **Install DriverLINX**. From **Install These DriverLINX Components** select **Install Drivers**. A welcome message is then displayed urging the user to close any open applications. Unless you have open applications select **Next**. The window that appears contains the license agreement for the DriveLINX driver. Be sure to read it to understand your rights and responsibilities. Once you accept the agreement select **Yes**.

Fill in the registration information in the following window. Note that this registration is independent of the WinSPF registration. The serial number used will be that on the envelope or registration card the CD came with. The next window shows the default program folder where the drivers will be installed. Unless you know of possible conflicts, select **Next** to continue the installation.

The installation program then copies files from the CD to your hard disk and registers the files with the operating system. After these operations are complete, exit the installation program using the **Exit** button and then select **Done** to close the driver installation program. At this time, restart your computer so all the registration data can take affect.

When the computer reboots and after Windows is loaded a **DriverLINX Plug and Play Wizard** is displayed. This tool is used to guide you through the somewhat complex hardware installation and driver configuration process. A word of caution: The DriverLINX Wizard uses Windows' hardware installation user interface. However, Windows may have some different recommendations than DriverLINX. Be sure to follow the directions in the DriverLINX Wizard, which are duplicated here. Failure to do so may cause installation problems.

Select the **Wizard** button at the bottom of the **DriverLINX Installation Wizard**. The Windows **Add Hardware Wizard** form is displayed with a descriptive message. Select **Next**. In the next form select the option with the message "No, I want to select the hardware from a list." even though Windows recommends the other method. Then select **Next** to continue.

In the next form, labeled **Hardware Types**, select **DriverLINX Drivers** or **? Other devices** and click **Next**. Now, jumping back to the **DriverLINX Wizard**, click the **DriverLINX** button to open a new page of instructions. Then, moving back to the **Hardware Installation** window you are faced with two options depending on whether you had to select **Other Devices** or not. If

DriverLINX Drivers was listed select **Keithley DAS-802 Analog Input Board** from the list of boards and then select **Next**. If **Other Devices** was your choice you are presented with a list of manufacturers. Scroll through the list until you find **Keithley Instruments, Inc**. and select it. Select **Keithley DAS-802 Analog Input Board** from the list of **Models** and the select **Next**. The Windows hardware installation will then search through its resources to find some spare capacity where the board can be installed. It then displays the resources that it will use. Unfortunately, these settings have nothing to do with whether or not the board is capable of being installed at this location. In fact, the chosen resources are nowhere near the address space that the board is capable of. However, because we will change the resource later, just select **Next**.

Switching back to the **DriverLINX Wizard**, select **Continue** for more instructions. Click **Finish** in the **Add New Hardware Wizard** window. This will prompt a few messages urging you to restart your computer. Choose **No** each time. We will restart the computer later when the total configuration is complete.

Back in the **DriverLINX Wizard**, select the **Device Manager** button. This opens the **System Properties** window. Select the **Device Manager** tab if it is not selected for you. The tree under **DriverLINX Drivers** should be expanded to show the **Keithley DAS-802 Analog Input Board** listing. Highlight the selection, select the **Properties** tab and then select the **Resources** tab. Highlight the **Input/Output Range** and select **Change Setting**. Use the arrow buttons next to the **Value** box to scroll through possible addresses. Select a valid address for the DAS board from the list in this manual. Note: the address is in hexadecimal notation, i.e. 0300 – 0307 for an address of 300 hex.. After selecting an address review the **Conflict Information** box to be sure it shows "No devices are conflicting." If this is not the case, select another address until one matches the manual list and shows no conflict. Select **OK** when done. Then check the **Interrupt Request**, select a value from 2 to 7 and be sure there is no conflict. Select **OK** when satisfied. Write down the address and interrupt so the board can be correctly configured. Select **OK** to complete your selections. Windows will want to restart the computer again but select **No**. Close the **System Properties** window, return to the **DriverLINX Wizard** and choose **Continue**.

This action opens the **DriverLINX Configuration Panel**. Select the **Keithley DAS-802 Analog Input Board** from the list and select the **Configure** command button. In the **Logical Device Number** window enter 0 (zero) and then select the command button **OK**. Select **OK** in the

Configure DriverLINX Device window, select **Close** in the **DriverLINX Configuration Panel**, and select **Finish** in the **DriverLINX Wizard**.

Now you **MUST** restart your computer for the new hardware and driver settings to take affect. But rather than select the option given by Windows to restart the computer select **No** again and manually shut down the computer from the **Start** command. This will allow you to shut off the computer power to install the board. Configure the DAS-802 using the settings you wrote down earlier and restart the computer.

If at a later time it is necessary to make changes to the DriverLINX configuration, select **DriverLINX Configuration** in the Windows **Control Panel**. This will open the forms we have just described enabling you to make the appropriate changes.

Windows NT 4.0 Installation

The following installation description is for Microsoft Windows NT 4.0 with service pack 3 or service pack 4 only. The DriverLINX drivers cannot be installed without these service packs, which can be downloaded from Microsoft's web site.

The first step in installing the driver is to find spare address space and interrupts. From the NT **Start** button select **Programs**, **Administrative Tools** and **Windows NT Diagnostics**. Select the **Resources** tab, which will display a list of interrupts (IRQ) currently being used for devices in your computer. Write down the IRQ numbers between 2 and 7 that are **NOT** currently displayed. Now, select the **I/O Port** control button to show a list of **I/O Memory** locations that are currently being used. Again, write down the valid DAS-802 addresses that are **NOT** currently being used for later reference. Then close the forms in preparation for the actual installation.

To install the DAS-802 driver insert the CD in your computer's CD drive. The CD should automatically start. If not, use **Add/Remove Programs** from the Windows **Control Panel**.

From the **DriverLINX CD Browser Map** select **Install DriverLINX**. From **Install These DriverLINX Components** select **Install Drivers**. A welcome message is then displayed urging the user to close any open applications. Unless you have open applications select **Next**. The window that appears contains the license agreement for the DriveLINX driver. Be sure to read it

to understand your rights and responsibilities. Once you accept the agreement select **Yes**.

Fill in the registration information in the following window. Note that this registration is independent of the WinSPF registration. The serial number used will be that on the envelope or registration card the CD came with. The next window shows the default program folder where the drivers will be installed. Unless you know of possible conflicts, select **Next** to continue the installation.

The installation program then copies files from the CD to your hard disk and registers the files with the operating system. After these operations are complete, exit the installation program using the **Exit** button and then select **Done** to close the driver installation program. At this time, restart your computer so all the registration data can take affect.

When Windows loads again a DriverLINX Wizard is displayed showing instructions and the **DriverLINX Configuration Panel**. Select **Keithley DAS-800 Series (KMB800)** in the configuration window and then select **Create**. Enter **0** (zero) in the **Select Logical Device Number** window and select **OK**.

In the **Configure DriverLINX Devices** window select **DAS-802** from the model list. Enter an address from the spare list you created earlier, using Hex format, i.e. 0x300 for 300 hex. Then select the **Analog Input** tab and choose an interrupt on your spare list. Select **OK** to close the form.

Select **Close** in the **DriverLINX Configuration Panel**. When the **Device Change** message box is displayed choose not to restart your computer now. Then shut down the computer from the Start button and when notified, shut the computer's power off. Configure the DAS-802 jumpers according to the address and interrupt you selected earlier and install the board in the computer.

Now you can restart your computer. The newly registered device driver and board will then be active for use. You can check the registration by reviewing the resources under **Windows Diagnostics** again. You should find entries for the DAS-802 for the interrupt location and the I/O Port address you entered earlier.

If you need to change the board address or interrupt at any time, change the jumpers as required and reconfigure the driver by using the DriverLINX tool in the **Windows NT Control**

Panel.

WinSPF Software Installation

Before beginning WinSPF installation close all open applications. Installation will not be successful if shared files are already opened. During installation you will be asked to close applications. If you haven't already done so, you will be forced to exit setup, close applications and start all over.

WinSPF is supplied on 4 diskettes. To install the software insert the disk labeled "Disk 1 of [n]" in the floppy drive and select **Add/Remove Programs** from the Windows **Control Panel**. Select the **Install** button. The install application will instruct you to load the application's first installation disk or CD and click **Next**. The program will then search the computer's media and find the WinSPF setup program and display **a:\setup**. Select **Finish** to commence the actual installation.

At the beginning of the installation, **Setup** shows a welcome message. One of the instructions is to be sure that all applications are closed before continuing the installation. If no applications are opened select **Next**. The next window displayed contains information about the version of WinSPF that is being installed. It describes changes that have been made since the last version of the software.

The next window displayed allows you to enter the path where you wish WinSPF to be installed. Microsoft currently recommends that all third-party applications be installed in the **\Program Files** folder. This is the default used in the form. Unless you have a particular reason for changing it, we recommend that you use the default.

The next window asked into which folder you wish WinSPF to be installed. Again we recommend that you use the default of **WinSPF** to make the application easier to access. Selecting **Next** closes the form and opens a review form describing installation information. Review the information, selecting **Next** to continue or **Back** to make changes.

Setup will then copy files from the diskettes to your system's hard drive, prompting you to load diskettes as required. When the files are copied and registered on your computer your winSPF group is created including the WinSPF executable and help system icons. Finally, the setup

complete notice is displayed providing the options to restart your computer now or restarting your computer later. Before WinSPF can operate correctly you MUST restart your computer. Only by doing so will the new registrations take affect and be used by WinSPF. Make your choice, select **Finish** and remove all diskettes from your floppy drive to complete the installation.

When your computer restarts the WinSPF group is displayed under the **Start\Programs** list and a shortcut to WinSPF is provided on your desktop for easy access.

Graphics Card Set-Up

WinSPF is designed for a minimum 800x600 screen resolution operating in a 256 color mode. Although WinSPF can be used at lower resolutions, scroll bars will be automatically installed so the user can have access to the entire WinSPF display.

Use the display icon in the Windows **Control Panel** to change the display's operating features.

Software Registration

The first time WinSPF is started the form in Figure 9 is displayed for user input. There are two important reasons for filling out the form. First, some of the information such as **Comm Port** and **DAC Address** are essential to the operation of the SPF-290. Secondly, if the registration information is not provided, the software attempts to collect this information each time WinSPF starts.

During the registration the software does a preliminary test of the **Comm Port.** It checks that the choice you selected is available on your computer. If not, on error message is displayed. Note: this test does not check if the SPF-290S is connected; only that your computer hardware actually has the requested port.

Note: The product serial number in the registration form is the WinSPF software serial number.

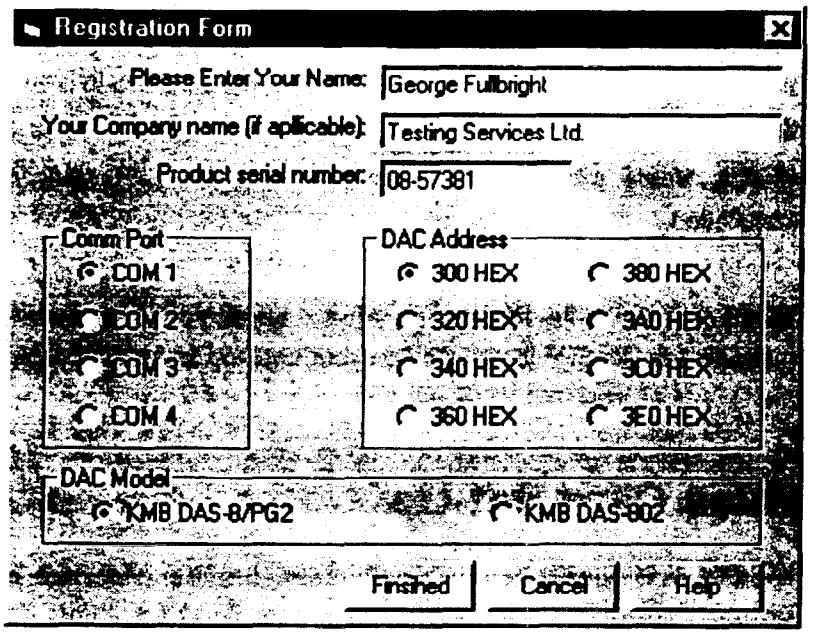


Figure 9 - Software Registration Form

Hardware Configuration

Normally, the SPF-290 hardware settings are established when WinSPF is installed. Filling out the registration form also sets the locations where WinSPF will look for the hardware. However, if a mistake was made or a hardware conflict has subsequently been found, use the hardware configuration form to change the hardware parameters and test the changes.

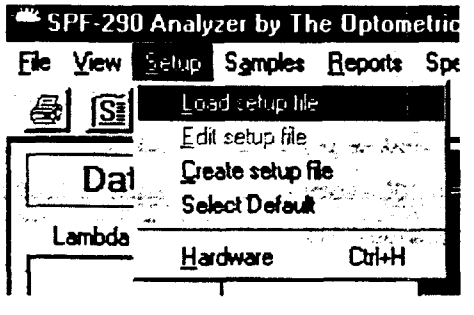


Figure 10 - Setup Menu

Selecting **Hardware** from the **Setup** menu opens the hardware setup form. The user can then choose to (1) select the serial port (comm port) by which the computer communicates to the SPF-290, (2) select the model for the data acquisition card (DAC), and/or (3) select the address

for the data acquisition card.

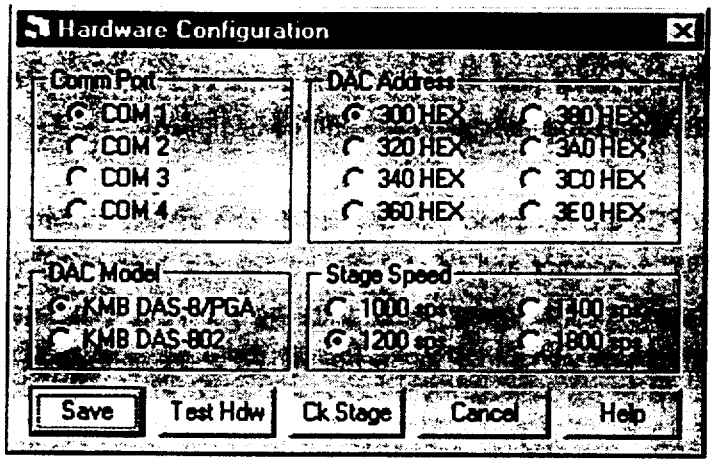


Figure 11 - Hardware Options

Test the configuration by selecting **Test Hdw**. WinSPF checks to see that the new settings are valid by attempting to communicate to the SPF-290 using the selected comm port and initializing the DAC. If either fails, error messages are displayed so that more changes can be made.

Over the years the design of the SPF-290 X-Y stage has been modified to yield better performance. Generally, better performance allows the stage to operate at faster speeds. However, the SPF-290 stage requires more maintenance than other components because of its tight tolerances. Thus, the torque required to drive the stage is a function of design, use, etc. Because the motor torque is a function of step rates, the hardware setup allows the user to change the stage motor step rates if performance varies. If one wishes to change the step rate to increase speed or solve a mechanical problem, select a step rate from the options shown under **Stage Speed**. To check the stage performance with the current setting, select the **Ck Stage** command button. The software will find the stage "home" position and cycle through all 12 stage positions at the selected step rate.

If satisfied with the stage performance and the other hardware settings, select **Save** to store the settings to the SPF-290 computer's hard disk for future use.

Changes to the Comm Port Setup

First let's clarify some terminology. **Comm. Port** is an abbreviation for communications port.

PC communications ports that send and receive data in series rather than in parallel are often referred to as serial ports. (Note: a PC's parallel port is often used for the system printer.) The serial ports are often labeled COM 1, COM 2, COM [n], etc. Thus, COM 1 = communications port #1 = serial port #1. All these terms and labels are used interchangeably in operating systems and documentation so don't be confused.

Most PCs are equipped with two serial ports usually labeled COM 1 or COM 2. COM 1 is a 9-pin "D" connector and COM 2 can be either a 9-pin or 25-pin "D" connector. However, users may wish to add more serial ports by installing additional hardware. Thus, WinSPF can communicate with one of four serial ports that are configured in the Windows environment.

Typically, two devices cannot share the same logical communications port without additional addressing. COM 1 is often used for a serial mouse and, thus, cannot be used for other devices. In this case, unless some other device such as a modem is occupying COM 2, the SPF-290 should be configured to use COM 2. Suppose that a serial mouse is configured for COM 1 and a modem is installed using COM 2. Usually, this means that the connector on the back of the computer labeled COM 2 is disabled. Thus, there is no current means of connecting the SPF-290 computer to the SPF-290 Analyzer.

At least a two step process must be taken to install the SPF-290. First, the modem must be configured for some other serial port. (Up to 8 logical serial ports are available with many modems.) Second, the second serial port must be enabled using the computer's BIOS configuration. To facilitate this change it may also be necessary to change the Windows port configuration. Because of the many possible variations in BIOS configurations and operating system details, refer to your computer and operating system manuals for more information.

If the SPF-290 computer uses a PS-2 or bus mouse, COM 1 will probably be available for use by the SPF-290.

Once the available comm. port is identified, select the appropriate option in the hardware configuration form.

Changes to the DAC Model Setup

The SPF-290 can use one of two data acquisition cards (DAC) to convert SPF-290 readings into computer compatible code. Use the hardware configuration form to choose the board installed in your computer. The form is accessible from the **Setup** menu.

The DAC model is printed on the upper-left corner of the board. Select the option that corresponds to the label on the board. Selecting **Test Hdw** will test the communications between the software and hardware, and inform the user of the status. If communications is confirmed, use **Save** to store the configuration to disk.

If communications fails it may also be necessary to change the DAC address.

Changes to the DAC Address Setup

The data acquisition card's (DAC) address must be set to avoid conflicts with other devices installed in the SPF-290 computer. This operation is done prior to installing the DAC in the SPF-290 computer by setting a series of switches and jumpers on the board. If conflicts exist, a computer instruction could be intercepted by the incorrect device, possibly causing problems.

Once the hardware is configured the software must know where to send instructions. This is done using the hardware configuration form available through the **Setup** menu. Select the option under the **DAC Address** heading that agrees with the address setting of the DAC installed in the SPF-290 computer. Selecting **Test Hdw** will test the communications between the software and hardware, and inform the user of the status. If communications is confirmed, use ***Save*** to store the configuration to disk.

User Interface and System Displays

Overview

WinSPF is written in Microsoft Visual Basic 6.0 and uses many of the standard features available under Window 95, 98 and NT. Wherever possible the software uses procedures and forms that an experienced Windows user finds familiar.

The WinSPF user interface consists of a toolbar, a menu bar, a data display area that changes depending on the measurement status and a status bar that describes the current state of the measurement. Forms and message boxes are displayed as required to guide the user through the measurement cycle.

Standard Windows tools allows the user to maximize and minimize windows.

Icons and menu selection items can have two states depending on their availability. If the item or icon is gray the feature is disabled. This indicates that some other operation must occur before the procedure can be used. When enabled the icon or menu item will be in full color or black text.

The Tool Bar

The WinSPF toolbar consists of a series of icons that access the most commonly used procedures for the SPF-290. Tool tips for each icon are displayed when the mouse pointer is briefly positioned over the icon. Clicking the left mouse button activates the procedure indicated by the icon.

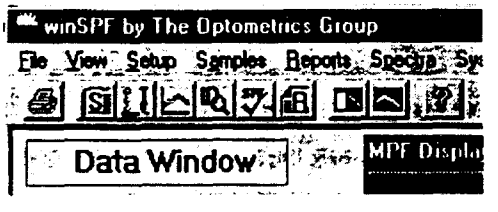


Figure 12 - The Tool Bar

The following describes the icon functions beginning from the left of the screen.

1. Printer Icon - This procedure is only available after one run has been completed. Calling the procedure will print a SPF summary report on the Widows default printer. To select a different printer or control printer features use Page Setup in the File menu.
2. Sample Setup Icon – Selecting this icon opens the load setup dialog box showing the list of setup files stored on the computer's hard disk. The user can select a file from the list that will be loaded upon selecting the *Open* command button.
3. SPF Initialize – This icon is used to call the procedure to set the stage and Monochromator home positions and assists the user in setting the controls on the SPF-290 front panel.
4. Reference Scan – This icon is enabled only after SPF-290 initialization is complete. In most cases acquiring a reference scan is accessed through the **Sample ID** form.
5. Sample ID – The procedure called by selecting this icon opens a form for data entry specific to the sample including the sample name or code, the data file name, date and time, etc.
6. System Test – Periodically the SPF-290 should be checked to ensure consistent operation. Selecting this icon opens the system test log form for user input and to perform the test.
7. Review Data – At the conclusion of each run the collected data can be stored to the computer's hard disk. By selecting this icon, a file access dialog box opens showing the data files. Selecting a file and pressing **Open** in the dialog box loads the data file into memory, recalculates the results and displays the SPF on-line report.
8. Normal Graph – The graphical display can be displayed maximized, assume the full size of the WinSPF window. Once maximized, it can be returned to its normal size, revealing the tabular data, by selecting this icon.
9. Maximized Graph - By selecting this icon, the user can use the full WinSPF window to display the graphical data.
10. Help – Loads the on-line help system.

The Menu Bar

The WinSPF menu bar allows user access to all program features. Selecting the main heading opens a menu related to the heading topic. Labels in gray are currently inaccessible because prior conditions have not been met. Clicking the black labels or using the hot keys, shown as the underlined letter, access the procedure.

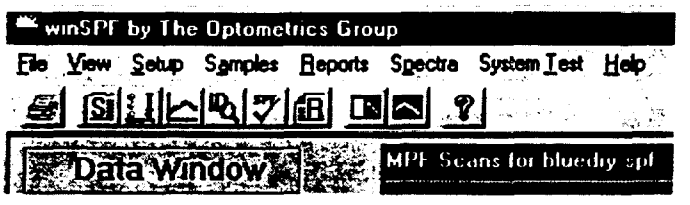


Figure 13 - The Menu Bar

The following is a brief description of each option contained in the menu bar.

1. File – The file heading is included in the WinSPF menu bar to be compatible with other Windows applications. However, few of the standard file items are included because the WinSPF file operations are too specific. The menu is used for printer access features and to exit the software. The **Open** selection is used only for the demo mode of operation and is normally disabled. **Page Setup** accesses the Windows printer interface allowing the selection of available printers and other features specific to the selected printer. When a report is available, the Print selection prints a summary, detail or graph SPF report on the system printer. **Exit** closes WinSPF and returns control to the Windows operating system.

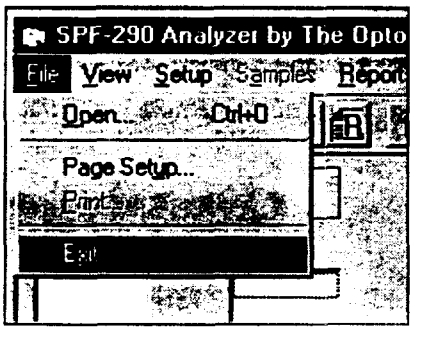


Figure 14 - The FILE Menu

2. View – This menu is also included to be compatible with standard Windows practice. It controls whether or not the toolbar and status bars are visible.
3. Setup – The selections included here allow access to all the sample and hardware setup parameters. Selecting **Load setup file** opens a dialog box of stored sample setup files for selection and use. Selecting **Edit setup file** allows the user to change the parameters in the currently loaded setup file and either use the changes for the current run or save the changes. **Create setup file** allows the user to make up a new set of operating parameters from the WinSPF defaults. The **Select Default** item opens a file list of the setup parameters files currently stored on the hard disk. Selecting a file from the list will automatically load the file every time WinSPF is started. Selecting **Hardware** opens a separate form that allows changes

to the software hardware interface.

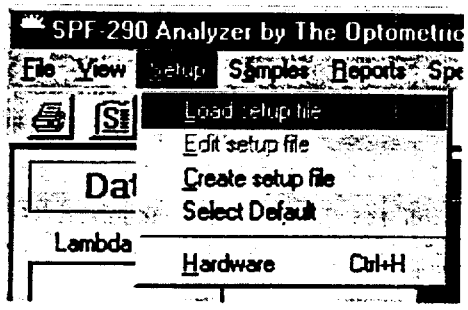


Figure 15 - The SETUP Menu

4. Samples – The commands under the **Samples** heading relate to operations of actually taking sample measurements. Before a sample measurement can be made the hardware must be initialized. Selecting **Initialize** automatically performs this function. Selecting **Optimize** calls the signal level routine that enables the user to set the **Gain** and **H.V.** controls on the front panel of the SPF-290. Selecting **Sample I.D.** opens a form where report header data is entered. **Reference Scan** calls the routine for acquiring a scan of a blank sample substrate. **Run Samples** makes scans of the sample applied to the sample substrate.

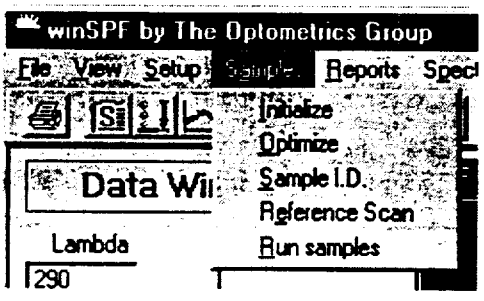


Figure 16 - The SAMPLE Menu

5. Reports – WinSPF offers several controls for reporting. The first choice, **Format Report Data**, opens a second menu. **Link Assay Files** opens a file dialog box by which means the user can select a group of stored data files that can be combined into an assay report. **Change Calc Method** opens a form allowing the user to change the method by which standard deviation is calculated. **Review Comment** opens a form allowing changes to the comments entered in the **Sample ID** form. **Save Report** allows the user to save data currently in memory to any storage media. The file name defaults to the current data file name whether the data is from a current

run or from **Data Review**.

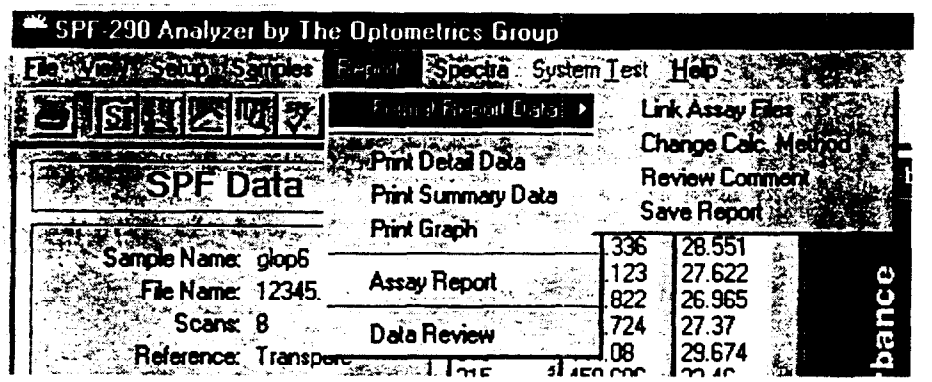


Figure 17 - The REPORT Menu

Once report data is available, selecting any of the print choices will print the chosen report on the system printer. The last two items in the **Reports** menu load stored data into memory and create reports. The first, **Assay Reports**, opens the file dialog showing current assay link files. Selecting a file loads the data from all the data files and automatically creates the SPF report. Selecting **Data Review** loads individual data files. Files loaded from disk can be reviewed the same as sample runs, excluding scans, changing calculation methods, etc.

6. Spectra – This menu allows access to functions relating to the Solar and Erythemal spectra procedures. Spectra files can be **Loaded** into memory, **Displayed**, or **Edited**. Once a pair of spectra files is loaded, their **Combined Response** can be displayed.

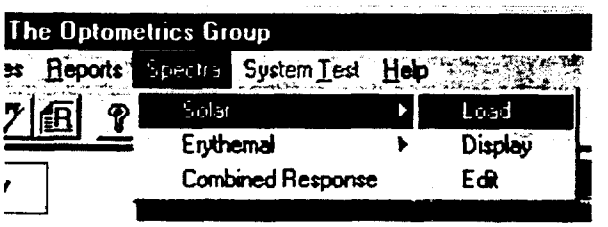


Figure 18 - The SPECTRA Menu

7. System Test – Menu selections include **Test Log** and **Print Test Report**. Selecting the first opens a form for user input and then automatically performs the system test, storing the results to disk. The second choice outputs the report to the system printer.

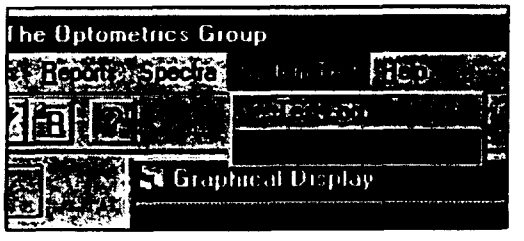


Figure 19 - The SYSTEM TEST Menu

8. Help – Displays the on-line help system.

Display Features

Basically, the WinSPF display screen is divided into two sections. The left side displays numerical data collected during the scan cycle while the right side displays the same data in graphical format.

Reference Scan - In figure 20, the Reference Scan screen, the left side of the display shows the wavelengths at which data was taken under the heading **Lambda** and the response in **Volts**.

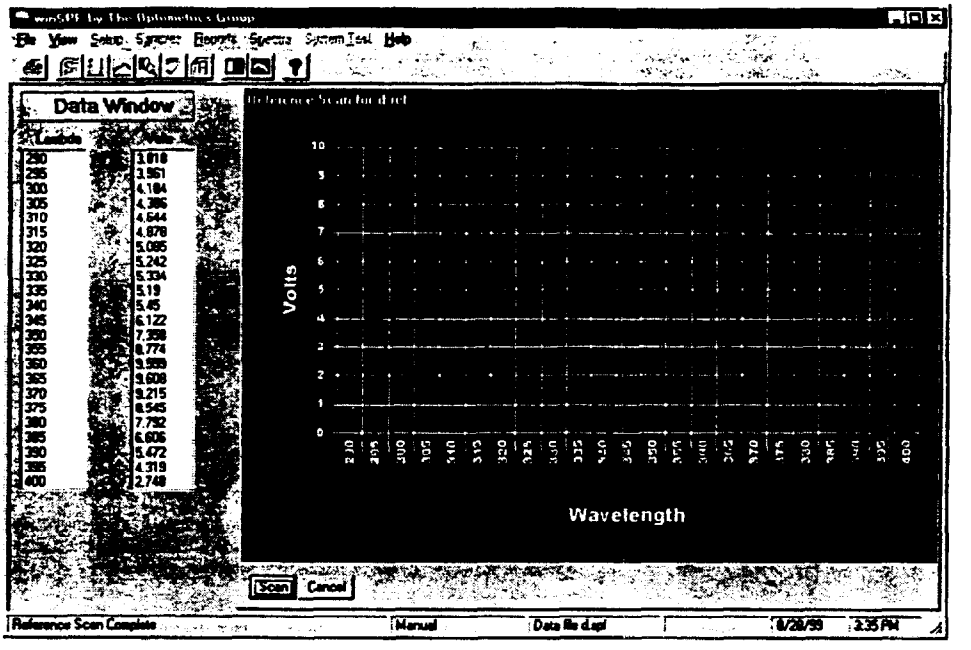


Figure 20 - The Reference Scan Screen

The right side of the display shows the same data plotted as **Volts** vs. **Wavelength (nm).** Microsoft Visual Basic's graphical package is column-based. Therefore, the data point for some wavelength, i.e. 290nm is plotted at the middle of a column rather that on an abscissa ordinate. The command buttons at the bottom of the graphical display are visible only after the scan is complete. Selecting **Scan** will begin the sample scan procedure.

Sample Scan – Figure 21 shows the display at the completion of a set of sample scans. Several controls have been added to the display. At the bottom of the **Data Window** is a **Scan Select** control. Clicking the right arrow increments the scan number display and changes the data in the **Data Window** to that corresponding to the scan shown in the **Scan Select** display. By clicking the left arrow the scan number is decremented. Thus, the user can review the raw data from all scans.

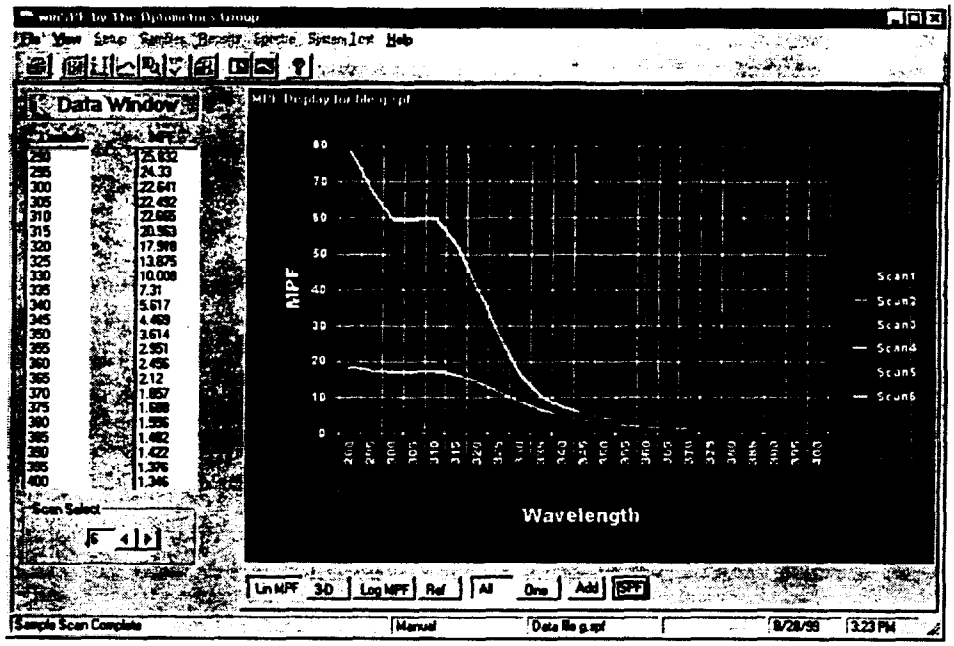


Figure 21 - The Sample Scan Screen

The graphical display plots the data for each scan in a different color. A legend on the right of the display correlates color to scan number.

The controls at the bottom of the graphical display control how the data is plotted and gives access to other operating features. From the left, the first three controls change how the current data is plotted. All three controls plot MPF data. The button labeled **LinMPF** plots linear MPF. The second, **3D**, plots the same data but in 3-dimensional format. The third plots absorbance as Log(10)MPF.

The **Ref** command button displays the current reference scan. The user can cycle through the four choices at will without causing any changes to the data, etc.

The next two command buttons, **All** and **One**, also control the data display. Currently shown in the **All** mode, the graphical display shows all the collected scans. Selecting **One** will plot just the data shown in the **Scan Select** display. Cycling the **Scan Select** display with the arrow keys changes the scan displayed in both the **Data Window** and plotted in the **Graphical Display**.

One of the greatest difficulties in making a SPF measurements is the ability to uniformly apply

the product to the substrate. If the application were perfectly uniform there would be need of but one scan measurement. However, to ensure accurate SPF predictions it is best to scan at several locations on the sample. The possibility remains that local variations in sample thickness may cause extreme fluctuation in transmission, which may not be representative of the sample. Thus, suspect scans can be eliminated from the calculations.

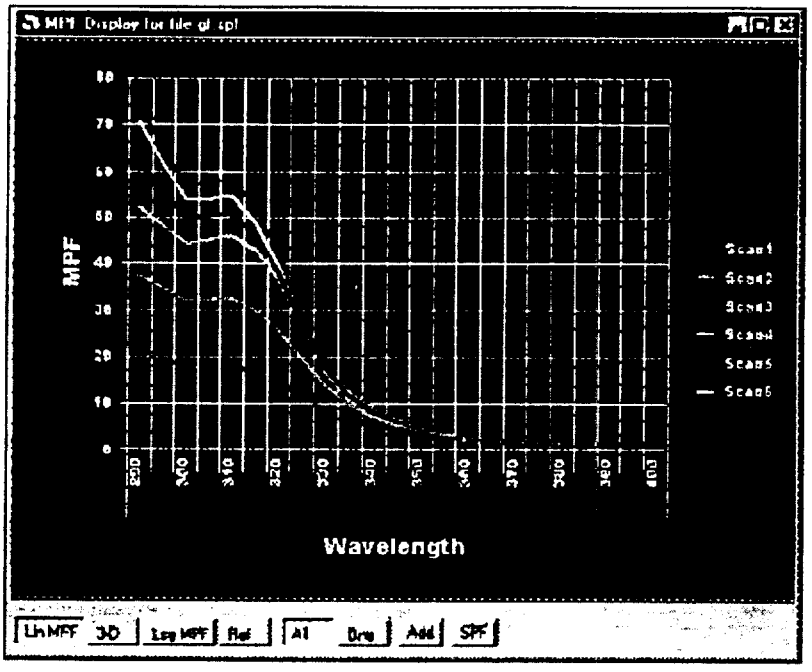


Figure 22 - MPF data display

Selecting a scan by either clicking on the plot line or the legend line changes the line type. If the line type is continuous, clicking will change the line type to dotted. Clicking the plot line again will return it to continuous. If a plotted line is dotted, it is excluded from further calculations.

At no time are the data from the excluded scan eliminated. When the data are stored to disk the data from the excluded scan are included. However, the data file includes a list of the scans that are included as valid. Thus, if the run data are reviewed, the calculations, plots, etc. will be identical to the conditions when the data were stored.

The **Add** command button allows the user to add scans for the run. Selecting the button opens a form to enter the desired number of scans to add. At no time can the total number of scans exceed 12.

Selecting the **SPF** command button commences the report calculations and changes the display showing the on-line summary report. As shown in figure 23 the graphical display is similar to that in the MPF data display except that an average MPF is plotted and shown as a dashed line type. Some of the command buttons on the bottom of the graphical display are familiar while two new command buttons are added. The left four buttons perform the same operations as described above. The **MPF** button switches the display back to the previous report showing MPF and individual scan data. Thus, the user can toggle between the two reports for detailed data review, etc. Each time the **SPF** button is selected the SPF report is recalculated. Therefore, if a scan mode is changed, between either excluded or included, the SPF report will be calculated based on the current scan status.

The **Next** command button opens a form allowing the user to save the run data to disk and prepare for the next sample run.

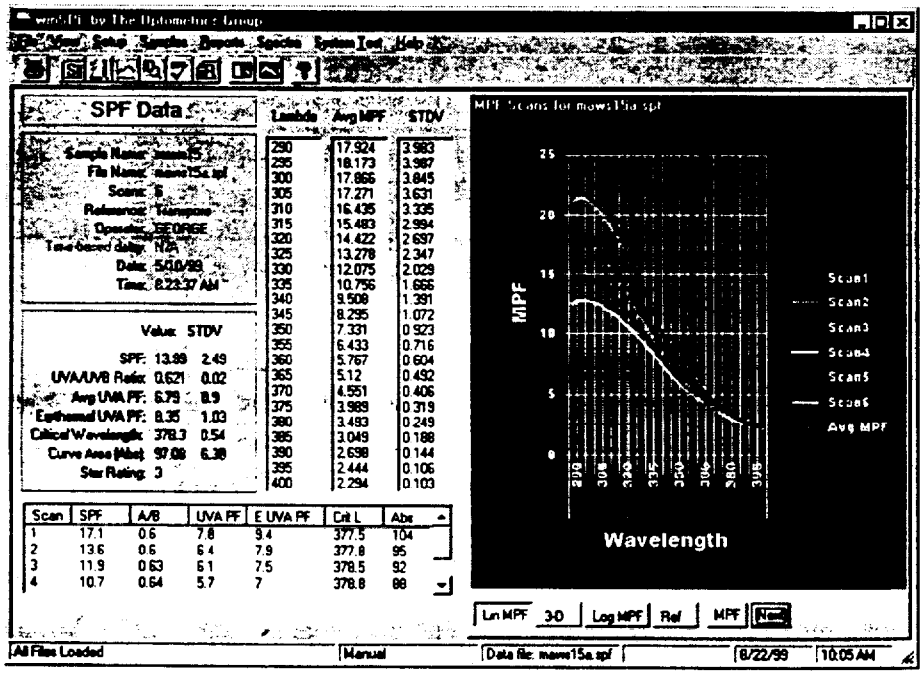


Figure 23 - SPF Summary Data display

The top of the **SPF Data** region of the SPF report shows general information concerning the measurement. This data is included in headers for printed reports. The next lower section displays computed results of the measurement set. Definitions and equations used for the

calculations are described elsewhere.

The columns next to the **SPF Data** frame show the sample mean or average MPF at each wavelength along with the standard deviation for the scans. Each scan's SPF data are shown at the bottom of the SPF Data display.

Status Bar

The bar along the bottom of WinSPF display shows the system's status.

Figure 24 - Status Bar

The left-most panel supplies information about the current procedure. The next panel shows the operating mode. The third panel shows the name of the data file in which all data will be stored. The fourth panel is reserved for the time-based mode and shows the number of seconds until the stage begins moving into position for the next scan. The remaining panels show the current date and time.

Sample Parameter Setup

Overview

The SPF-290 can be operated in one of two modes, standard and assay. By adding the stage to the SPF, additional modes become available, including timed based. Within any one of these modes, there are several features that can be chosen to control the means by which the SPF measurement will be made. In fact, the SPF has more than 30 parameters that can be used to control the measurement.

To require a user to define each of these parameters each time a measurement is taken would be a difficult task. Thus, WinSPF provides a means of constructing many different recipes that can be used each time a certain product is tested or to test the same product in several different ways.

The setup files are stored on the SPF-290 computer's hard disk. A setup file template is automatically available by selecting **Create** in the **Setup** menu. Each tab represents one of the user-changeable options available. They include:

- Mode
- Stage (Additional Modes)
- Calc Method
- Readings
- Spectra

The user can then make changes to each of the available options to create customized sampling parameters. These changes can be tested before saving the set-up file. Once saved, the user can specify a custom setup file for use in testing and be sure that the test will be repeated with the same parameters each time.

Loading the Setup File

The first step in performing a test measurement is to load a setup file from disk. Selecting **Load setup file** from the **Setup** menu opens a dialog box showing the list of setup files on the disk. Selecting one will load the file in memory for use by the system.

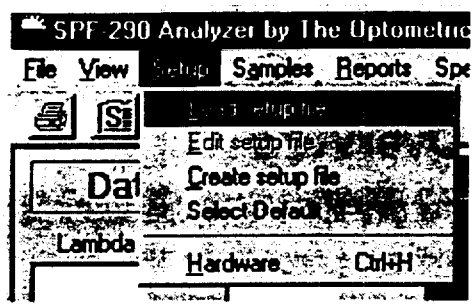


Figure 25 - The SETUP Menu

By choosing **Edit setup file** from the **Setup** menu the user can change a loaded file. The changes can be stored to disk by selecting the **Save** command button. An alternative is to use the **Apply** command button. This loads the changes into memory but does not save them to disk. A test measurement can then be made after which the user can decide to save the changes permanently or not.

To create a new setup file select **Create setup file** in the **Setup** menu. This operation can be performed before loading any setup file into memory. After the choice is made a dialog box is opened that appears the same as the load dialog box. However, the difference is that one must enter the name for the new file in the **File name** field. If a duplicate name is entered a message box opens questioning the user if they wish to overwrite an existing file. If **Yes** is chosen the previous file's parameters will be lost.

The **Hardware setup** is really a redundant feature of the SPF-290 software. It is only used if the hardware configuration has changed after the initial installation of WinSPF.

Default Setup Parameters

There are four setup files supplied with WinSPF. They are:

- autoscan.par – a setup file when the SPF-290 is equipped with an x-y stage.
- manual.par – a setup file when the SPF-290 has no x-y stage.
- tbase.par – a setup file for the time-based measurement mode, and
- assay.par – a setup file for performing assay measurements.

These four files were configured by Optometrics based on our understanding of the general usage of the SPF-290. However, each file can be altered to better suit the conditions under which the user chooses to operate.

The default parameters for each file are shown in the following table.

Parameter	Auto Scan	Manual	TBase	Assay
Assay: No. of runs	N/A	N/A	N/A	6
Assay: Skip reference	N/A	N/A	N/A	Checked
Assay: Show each scan	N/A	N/A	N/A	Unchecked
No. of scans/sample	6	6	6	6
Time based: Stage position	N/A	N/A	7	N/A
Time based: Sample interval	N/A	N/A	40	N/A
Time based: Position between scans	N/A	N/A	Out of beam	N/A
Time based: Plot	N/A	N/A	SPF	N/A
Stage: Grid	Fixed	N/A	N/A	Fixed
Stage: Scan pattern	N/A	N/A	N/A	N/A
Calc. Method: SPF Standard Deviation	Classical STDV	Classical STDV	Classical STDV	Classical STDV
Calc. Method: Assay Calc. Method	STDV (n)	STDV (n)	STDV (n)	STDV (n)
Readings: Data Acquisition: No. of readings	10	10	10	10
Readings: Reading Interval	10	10	10	10
Readings: Store readings	As MPF	As MPF	As MPF	As MPF
Spectra: Solar spectra file	sp40n20z.sol	sp40n20z.sol	sp40n20z.sol	sp40n20z.sol
Spectra: Action spectra file	erythema.act	erythema.act	erythema.act	erythema.act

Figure 26 - Default Parameters

Sample Mode Options

There are three basic modes by which the SPF makes measurements.

- Standard,
- Timed Based, and
- Assay.

The standard mode makes wavelength scans at several locations on the sample holder, measuring the absorbance of the product at several wavelength intervals. If a sample stage is installed, the stage can be positioned in many different sequential patterns generated by the system, selected by the user, or chosen randomly by the software. If no stage is available, the user is instructed to reposition the sample after each scan. The measurement run can be anywhere between one and twelve scans.

At the completion of the scan set a screen report can be displayed showing various calculated

characteristics of the product along with a graphical plot of each scan's MPF and the mean of the scan set.

In the time-based mode the SPF-290 measures the affects of time on the absorbance of the product. The user can instruct the stage to leave the sample in the ultra-violet beam or to move the sample out of the beam between scans. The interval between scans is user controlled. To ensure that the only variable in the measurement is the absorbency of the product, scans are always made with the stage in the same, user-selected location.

The third mode performs an assay measurement on several samples from the same product lot. The user can select the number of samples used in the assay, the number of scans on each sample and whether or not to use the same reference scan for each sample (up to thirty-six (36) scans can be included in an assay). The resultant report will show the accumulated sample and scan data, and provides an indication of the consistency of the product either throughout one lot or from one lot to another.

In all modes the **No of Scans/Run** entry controls the initial number of scans that will be included in the sample run. More scans can be added if necessary.

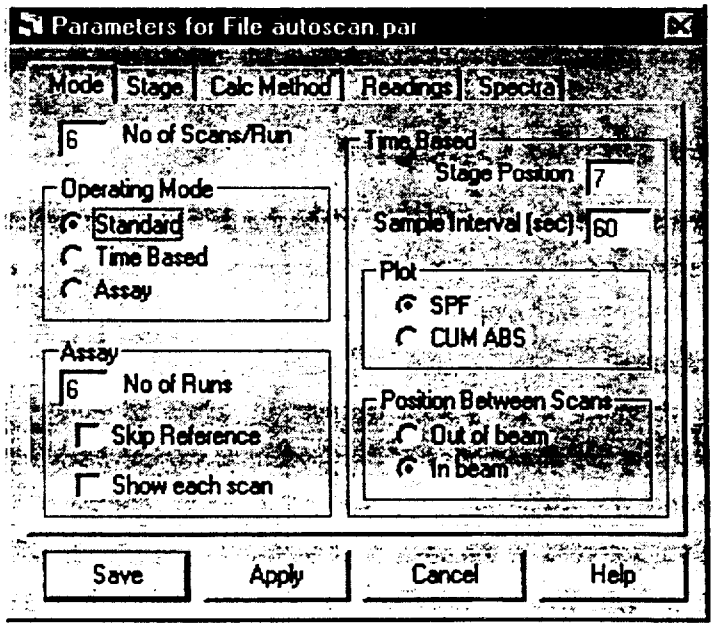


Figure 27 – Initial Mode Parameters

Stage Modes

The SPF-290 has 12 pre-defined locations as shown in the scan pattern frame of figure 28. The bottom of the frame represents the front of the SPF-290. By installing the stage on the SPF, three additional stage modes become available to the user.

- Fixed Grid,
- Random Grid, and
- User Specified.

The fixed grid mode uses a pattern determined by the SPF software based on the number of scans the user selects for the sample run.

The random grid mode uses the computer's random number generator to determine the sequential pattern for the stage. The algorithm selects a random sequence of twelve positions without repeating any position.

In the user specified grid mode the user can select a sequential stage pattern. Up to twelve positions are allowed. However, if the **Number of Scans/Run** entry is greater than the number of scan positions chosen by the user, the pattern repeats.

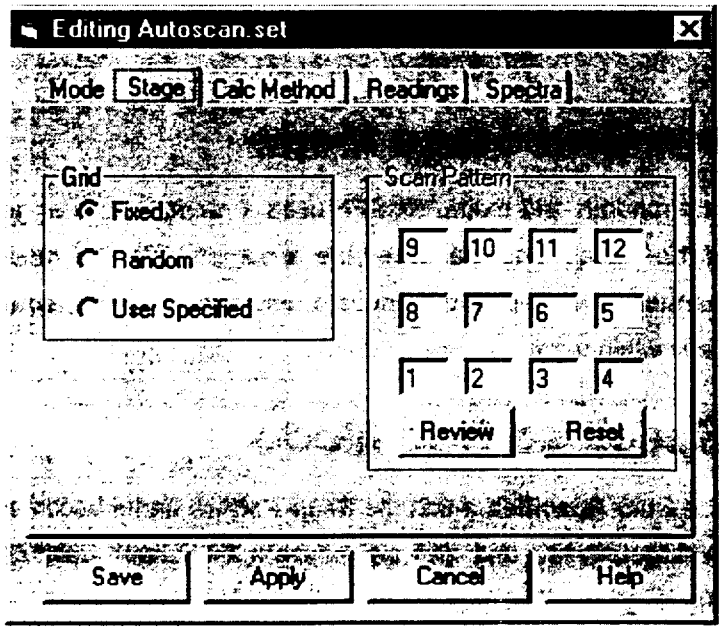


Figure 28 - Stage Mode Parameters

Fixed Grid Stage Mode

In the fixed-grid mode the user chooses the number of scans for the run and the system uses a stored pattern. Because the user can add to the number of scans after the original choice is satisfied, a full 12-position sequence is defined for each of the 12 choices. The following table shows the number of scans the user can select, the corresponding sequential pattern and the supplementary sequence, should the user decide more scans are necessary.

# of Scans	Initial Sequence	Subsequent Sequence
1	4	12,9,1,7,6,5,8,2,3,10,11
2	4,9	12,1,7,6,5,8,2,3,10,11
3	12,6,1	4,7,9,10,11,2,3,8,5
4	4,7,11,9	1,6,10,12,5,8,2,3
5	2,10,3,12,8	9,5,1,4,116,7
6	4,9,12,1,7,6	10,3,11,2,5,8
7	4,6,3,11,2,9,5	10,12,1,7,8
8	1,2,3,4,5,6,7,8	9,10,11,12
9	1,2,10,4,5,6,7,8,9	10,11,12
10	1,2,3,4,5,6,7,8,9,10	11,12
11	1,2,3,4,5,6,7,8,9,10,11	12
12	4,9,1,7,6,11,2,8,5,3,10,12	

Figure 29 - Fixed Grid Sequencing

Random Grid Stage Mode

In the random grid mode WinSPF uses a random number generator that is limited between 1 and 12. Each time the user runs a sample with the random pattern, the random number generator is re-seeded to produce a different numerical sequence. By design, no position can repeat within a run.

User Specified Grid Mode

In the **User Specified** mode the **Scan Pattern** frame becomes active. The user can then point to a stage position and click the mouse's left button. Each click changes the background from white to grey. The sequence of click locations becomes the sequence that the stage will assume during a measurement run. Clicking **Review** will clear selections to white and then automatically step through the chosen sequence, changing the background to gray again.

Not all positions must be selected. If one wishes the pattern to repeat one might select only positions 1, 7 and 9 for example. However, if the **No. of Scans/Run** was set to 6, the scan sequence would be 1, 7, 9, 1, 7, 9. If scans were added during a run, the pattern continues in this cycle.

Selecting **Reset** will clear the current sequence and allow a new set of entries.

Calculation Method

Under the Calc Method tab there are two main parameters that need to be assigned:

- SPF Standard Deviation and
- Assay Calc Data.

The first calculation method option refers to the means by which WinSPF calculates the standard deviation of various measurements. Classical sample standard deviation assumes a normal, Gausian distribution. Using classical standard deviation methods we calculate the result (SPF, UVA/UVB ratio, critical wavelength, etc.) for each scan in the run. Then we calculate the mean and standard deviation for the scans and report these values in the SPF report. The second option, referred to here as the Diffey method, is based on B. L. Diffey's paper on using Transpore™ tape as the substrate for SPF measurements.

Diffey's equation applies weighting by recognizing that the MPF measurements for a set of scans have some distribution. Therefore, the standard deviations of the MPF measurements at each wavelength are factored into the Diffey SPF standard deviation calculation. Diffey's equation generally yields a lower value for standard deviation. For more information, see the section on **Equations** at the end of this manual.

The second parameter, used for calculating results of assay samples, also has two options. The user can calculate the results and standard deviation using all the scans in the assay or the mean of the scans for each sample run. In either case the standard deviation is calculated classically.

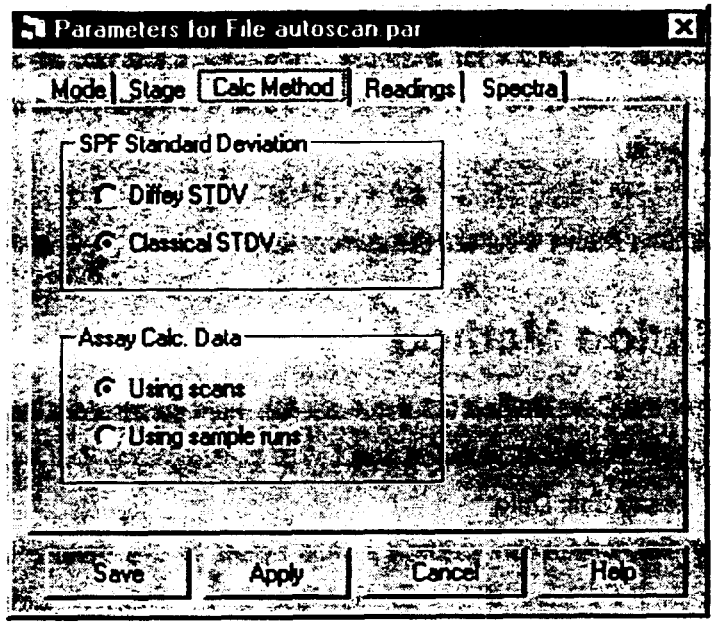


Figure 30 - Calc Method Parameters

Data Readings

The data acquisition board installed in the SPF computer converts the PMT (Photo Multiplier Tube) current into a digital representation of a voltage reading. The voltage is proportional to the intensity of the light source after it passes through the reference or sample, the integrating sphere, Monochromator, etc. The process of the data acquisition board taking a reading is sometimes called a "conversion". This is because the board uses an analog to digital (A-D) converter to read a voltage or current from a sensor and change the signal to a digital code that can be used by computers for storage and computation.

Several readings can be taken and averaged to reduce the effects of noise in the system electronics, providing a more reliable measurement. The value of the data reading parameters determines how many readings are taken after the Monochromator has been set to the desired wavelength and the time interval between readings.

The combination of the **number of readings** and the **reading interval** determines how long it takes the SPF-290 to make a set of SPF measurements. Obviously, the more readings at each wavelength and the longer the interval between readings, the longer a measurement will take. Thus, the user should choose the parameter settings to provide the best reading in the shortest

time.

System measurement noise is most often seen at low light levels. Thus, if one is testing a product with a SPF of 3, noise will have little impact on the measurement and as few as two readings are likely sufficient. However, if one is measuring a product with a potential SPF of 100, there will be significant absorption yielding low light levels. In this case the user may wish to take several readings at each wavelength.

The default settings of 10 readings at a 10 msec. (0.010 seconds) interval has been empirically confirmed to provide excellent performance for a broad range of SPF products.

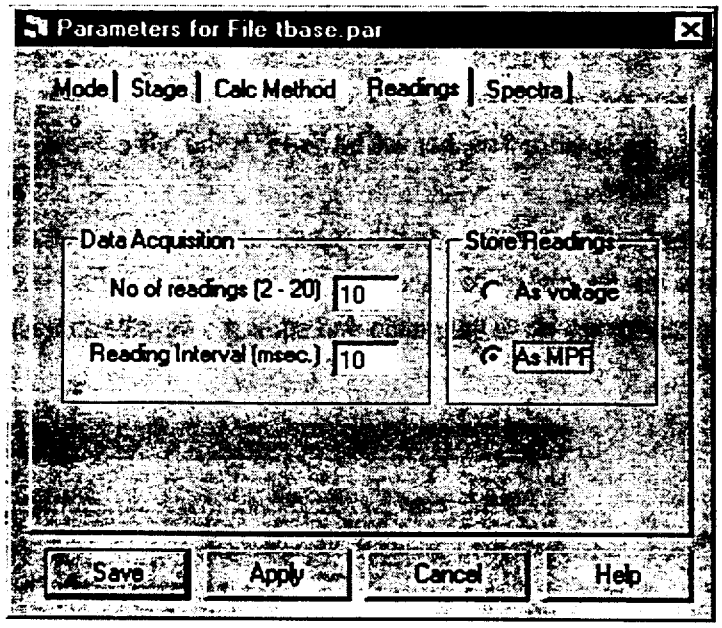


Figure 30 - Reading Parameters

The **Store Reading** option determines how the sample data are stored in the data file. If **As Voltage** is selected, the sample measurement at each wavelength is stored as a voltage. Because the reference scan is in voltage, this might be the preferred selection if one will perform additional calculations in some other program such as a spreadsheet.

The alternative is to store the data as **MPF**, which is the unit used for display when the data was collected.

Setup Spectra

Intensity of the sun in the ultraviolet region, and the response of the skin to the sun's rays, weight the SPF measurement. The intensity of the sun varies with many factors including the season, the latitude on the earth where the measurement is made, absorbency in the air, elevation above sea level, etc. Likewise, skin pigment, etc affect the response of the skin to solar radiation.

Standards have evolved for both the solar irradiance and the erythemal effectiveness. The solar irradiance spectrum is for midday summer sunlight at latitude 40 Deg. north with a solar zenith of 20 Deg. and an ozone thickness of 0.305 cm. The erythemal effectiveness standard was established by CIE (1987). Both these spectra are used in WinSPF.

The user can edit these spectra for different solar conditions and skin types. Thus, the user can specify the spectra files that will be used for the current test.

To change the spectra used in the setup file, select either **New Solar** or **New Action**. This opens the file dialog box showing the available spectra files from which to choose. Selecting from the list will close the dialog and show the new file name in the **Current** box.

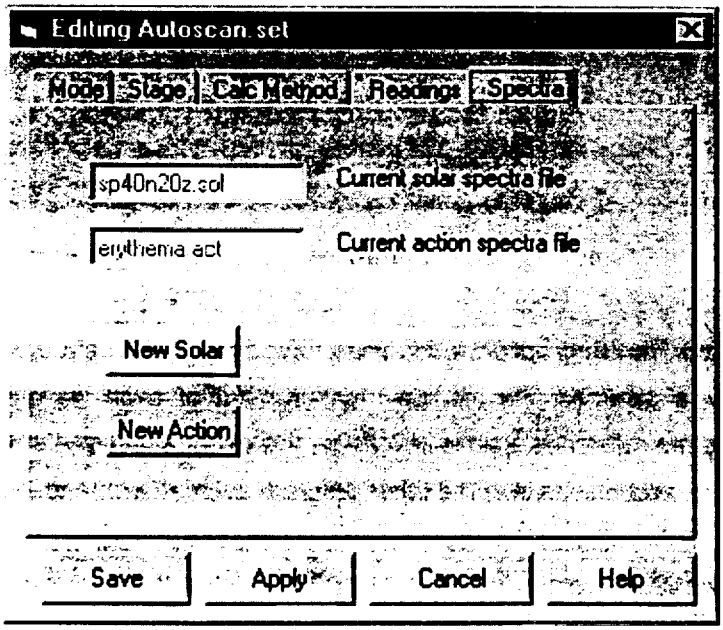


Figure 31 - Spectra Parameters

SPF Measurement Options

As mentioned in the last chapter, there are several modes available to the user. Chapter 5 discussed parameter options and details on changing those parameters. This chapter will discuss each mode option, in detail, with descriptions of how, when and why each mode might be chosen by the user. The Modes available are as follows:

- Standard,
- Timed Based (stage required),
- Assay,
- Fixed Grid (stage required),
- Random Grid (stage required), and
- User Specified (stage required).

Standard Mode

The most commonly used mode for the SPF-290 provides a single report for a set of sample scans. The sample is placed in the light beam while the SPF-290 Monochromator is used to determine the transmittance of the sample at various wavelengths. Between one and twelve measurements are made per sample with the user changing the sample position between scans (if no stage is installed) or WinSPF automatically positioning the stage.

WinSPF computes MPF at each wavelength for each scan and reports various data after all the scans have been collected. The WinSPF graphical plot shows the MPFs for each scan as well as the mean of the scan set. The user can toggle between a MPF report and a SPF report, excluding scans, reviewing the data plotted in several different formats, etc.

Time-based Mode

In the time-based mode, the SPF-290 takes successive measurements of the same sample at the same location. The resultant data is then analyzed to determine the affects of time on the absorbence of the sample. The time-based mode can only be used when a stage is installed on the SPF-290.

The user must specify the **Stage Position** at which the scan will be taken and the time interval between scans in seconds. The stage position is between 1 and 12 and the sample interval can

be as long as 3600 seconds (1 hour), the default stage position is 7. The minimum **Sample Interval** is variable depending on other parameters in the setup file; the number of readings, stage speed, and reading interval. The software calculates the minimum time interval based on these entries and the time it takes for various other SPF-290 operations.

While the scan data is being acquired, the sample is being exposed to the output of the SPF-290 light source. The lamp's spectral irradiance closely matches that of the sun in the ultra violet region. The user may wish to avoid prolonged sample exposure between scans or expose the sample to other illumination between scans. Thus, the user has the choice of leaving the sample **In Beam** between scans or having the stage automatically move **Out of Beam** between scans. In the latter case, the user can either leave the sample on the stage or remove it for other exposure. (Note: the time remaining before the stage begins moving for the next scan is displayed in the status bar on the bottom of the WinSPF main display.)

In the time-based mode the WinSPF report displays the same basic data as that shown in the standard SPF report. The plot options permit the user to plot the time-based data as either SPF or cumulative absorbance by selecting either **SPF** or **Cum ABS** in the **Plot** frame.

Assay Mode

In the assay mode, several samples from the same product lot can be measured and their data linked into a common report. Thus, the user can determine the consistency of the batch.

There are two options available for assay measurements. The first is to specify ahead of time that an assay measurement will be taken. The user selects the **Number of runs** to include in the assay, the **No. of Scans/Run** in each run and whether or not to **Skip Reference** between scans and use the same reference curve for all runs. Individual run data are acquired and written to disk. The file names are the same for all runs as that chosen in the **Sample ID** form. However, to distinguish one run from another, the file extension is incremented beginning with the number 1. Thus, an assay of three runs identified as sample A1234 will have the file names A1234.SP1, A1234.SP2 and A1234.SP3.

The software uses a link file that includes the names of the data files used for the report. The link file name is the same as that specified for the individual runs but with a .lnk file extension.

At the conclusion of an assay test a SPF report is produced showing calculated data and a

graphical plot of each scan's MPF vs. wavelength as well as the mean MPF for the entire data set.

The second method of producing an assay report is to post-link data files. This means to use several data files and combine their data into one report. In this case one has no control over the number of scans in each run because that was established before the initial data was taken. However, one can choose whether to **Show each scan** in the graphical plot or just the mean of each run. This is to avoid clutter and to better distinguish trends throughout the batch test.

Creating Assay Link Files

To create an assay link file select **Link Assay Files** from the **Reports** menu under the **Format Report Data** heading. The form shown below is displayed for transferring existing data file names into a link file from which assay reports can be created and displayed.

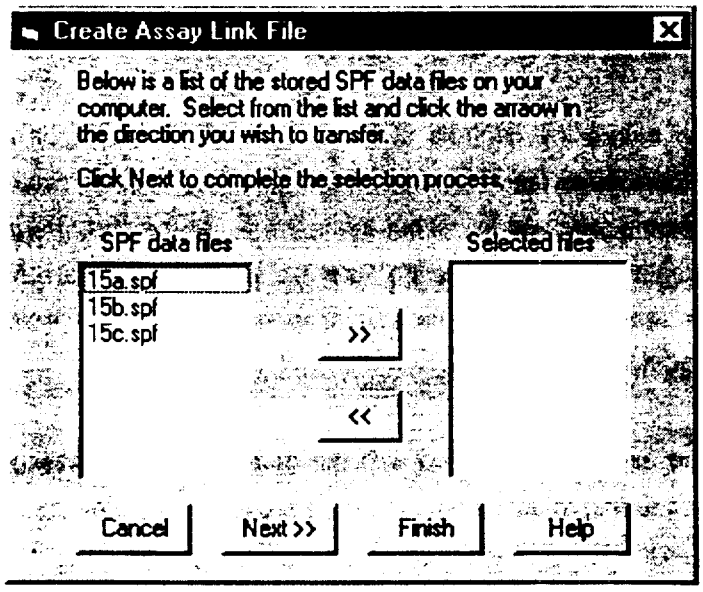


Figure 32 - Creating Assay Link Files

The left file window lists all of the data files currently residing on the SPF-290 computer's hard disk. Selecting a filename by highlighting it with the mouse pointer and then selecting the >> command button copies the file name into the **Selected Files** list. Continue selecting files and copying their names to the selected files list until all the desired files are included.

Once the proper list has been created, selecting **Next>>** opens the file dialog box showing the

link files that already exist on the computer's hard disk. Enter a new link file name in the **File name** field without an extension. WinSPF provides the proper file extension. Select **Save** to close the dialog, open the new link file and return to the **Create Link File** form.

Selecting **Finish** will write the **Selected files** list to the link file just created.

Making Assay Measurements

Making an assay measurement is very similar to making a standard SPF measurement. The difference is an added set of controls that are displayed after each run.

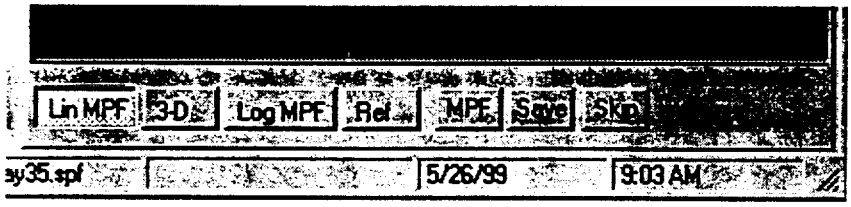


Figure 33 - Assay Measurements Control Bar

As shown above the controls at the bottom of the graphical display in the SPF report are different than those for other measurements. The controls **Save** and **Skip** are new while the control **Next** is removed for all but the last run. At the end of a measurement run the user can save the data to its file. After the data are saved the software returns to either acquire a new reference scan or the next sample scan depending on whether or not **Skip Reference** is selected in the sample setup.

Should the user be dissatisfied with the measurement, selecting **Skip** avoids saving the data before proceeding to acquiring another reference or sample scan.

After the final sample run is completed and saved two new controls replace the **Save** and **Skip** controls. Selecting **Assay** opens the assay link file and produces the full assay SPF report. The graphical display will show either all scans from all the linked files or just the average MPF values from each run. The main SPF report provides summary information such as the average SPF value, the average UVA/UVB ratio, etc. with the standard deviations calculated according to the method selected in the setup file. The individual scan or run data are displayed at the bottom of the SPF report depending on whether **Using Scans** or **Using Sample Runs** is selected in the setup file.

Selecting **Next** performs identically for assay measurements as for all other measurements. However, the assay report contains different data, more appropriate to the measurement and has a **.asy** file extension.

Creating and Using SPF Measurements

From a power-on start up, WinSPF allows the user to access several features other than just performing SPF-290 measurements, mostly without restrictions.

These features include:

- Reviewing stored data,
- Reviewing and editing the weighting spectra used for the SPF calculations,
- Create, edit or review sample setup parameters, and/or
- Perform a system test.

However, to perform the first sample measurement, WinSPF guides the user through a preferred sequence of actions. This sequence is basically similar regardless of the type of measurement mode. Thereafter, the user has more control over the sequence. Below is a summary of each action; more detail follows in the remaining pages of this chapter.

Sequence of Actions

1. Load Setup File – The user selecting a measurement setup file from disk or creating a new setup file determines how the measurement will be made. There are more than 30 parameters that affect operation. However, many parameters are dependent on which of three operating modes are selected.
2. Initialize System – This automatic operation establishes operating conditions for the SPF-290 hardware and communicates initial hardware settings to WinSPF.
3. Sample Identification – Although it is not really necessary to collect data, if one wishes to store the data and correlate the data to a sample, the user must enter some identification code. The form sets the data file name and reference file name to the same as the sample identification but adds appropriate file extensions.
4. Acquire Reference Scan – The SPF measurements are ratios of readings with a blank substrate and readings of the substrate with the product applied. The spectral response of the SPF-290 is a composite of (1) the spectral output of the SPF-290 lamp, (2) the efficiency of various optical components, and (3) the spectral sensitivity of the detector. Because the spectral response is not flat a scan of the desired wavelength range must be made and stored in the system memory for later calculations. Note: A reference scan can not be acquired unless a setup file is loaded and the system initialization is completed.

5. Acquire Sample Scans – Once a reference scan has been acquired the user applies the sample to the blank substrate. The sample holder is placed in the beam automatically, if the stage is installed, or manually. A collection of sample scans can be acquired for analysis.
6. Excluding Scans – The user can exclude scan data from final calculations if the data appears invalid.
7. Add Scans - The user can acquire additional sample scans to increase the likelihood of an improved SPF prediction.
8. Calculate Results – After all the data are collected and validated, the user can choose to compute the results of the test. The SPF value, UVA/UVB ratio, critical wavelength, etc. are computed and displayed for review.
9. Printed Reports - The user can select to print summary, detail or graph reports on the system printer. The graph is printed in color if a color printer is available.
10. Saving Data – After all on-line changes have been made the user can select **Next** from graphical display toolbar. This action opens a form allowing the user to proceed to the next sample run, save the data, etc. If **Save** is selected the data in memory will be saved to disk using the file name entered in the Sample ID form.
11. Concluding a Sample Scan – Another feature of the **Next** dialog form allows the user to prepare the system for subsequent sample runs. Exiting the form accesses the Sample ID form into which new data are entered and from which measurements are made.

Load Setup File

See more detail in Chapter 5

Initialize System

Power On System Test

The SPF performs a Power On System Test (POST) to determine the configuration of the system and to ensure that basic functionality exists. The test begins with WinSPF searching the SPF.INI file for operating information. Along with WinSPF registration information, the file includes the serial port that is used for communication between the SPF-290 motor(s) and the SPF-290 computer. It also includes the address of the DAC board used to acquire measurement data from the SPF-290.

Once the communication port and the DAC address are known, WinSPF proceeds to check that

the information is correct by attempting communication with the devices. The WinSPF passes configuration requests to the DAC and gets a return message if the board accepts and processes the request. If the board is not installed or the address is incorrect, the configuration request fails and a software error message is generated. Note, this test checks that the board is capable of correct operation but does not check that the board, which is in the computer, is connected to the SPF.

The communications port test is more complicated because not only does WinSPF check that the correct port is being used, but it also checks whether or not a sample stage is installed. The SPF can use three motors and controllers; one for the Monochromator and one each for the X and Y motion of the stage. For the SPF software to communicate to the correct motor over a common serial port, the motor controller boards must use different addresses. All three controllers receive the same commands but can recognize whether or not the command is intended for the receiving controller.

The presence of a stage is determined by sending an address command over the computer's communications port. If the SPF motor controllers return the proper code, WinSPF knows that a stage is installed and that different addresses have been successfully assigned to the three motor controllers.

SPF Initialization

As electrical power is applied to the SPF-290, the software performs a POST to check that various components are installed and operating. However, just because devices are installed and WinSPF can communicate with them, doesn't mean that the software and hardware know everything needed to operate correctly. Thus, before SPF measurements can be made, the system must determine the Monochromator wavelength setting, the position of the X-Y stage (if installed) and the proper settings for the SPF-290 front control panel potentiometers.

Selecting **Initialize** from the **Samples** menu starts initialization. If a stage is installed, the X and Y-axes are moved to a "home" position, which, in actuality, is a switch. Once the switches are triggered, the motors are stopped and the motor direction reversed. The motors then move the stage axes slowly until the switches clear. WinSPF then sets all position counters to zero and sends the stage to the sample load position.

The Monochromator initialization begins in much the same way. The motor drives the Monochromator to a "home" position, reverses and sets the counters as the switch clears.

However, for the wavelength of the Monochromator to be accurately set the software searches for the zero wavelength position by scanning across zero order and collecting data representing the intensity at various motor positions. WinSPF then scans the intensity profile data, using characteristics of the profile and linear interpolation to determine the location of the peak. Once the peak location is known, the Monochromator is moved to this position where its controller's counter is set to zero. Thus, the controller's zero position directly corresponds to the Monochromator's zero wavelength position.

The final step is for the user to set the gain and high voltage for the SPF-290 detector. The Monochromator is set at the wavelength that corresponds to the SPF-290's maximum signal output. The user is prompted to load a blank substrate in the sample holder (if a stage is installed) or in the beam. A scale and indicator are displayed. The user adjusts the gain and high voltage potentiometers on the front of the SPF-290 until the indicator is in the green region. Clicking **OK** causes the software to verify that the setting is within acceptable bounds. If all is well, the window is closed and the user can proceed to other operations. If the setting is incorrect, prompts are displayed with instructions.

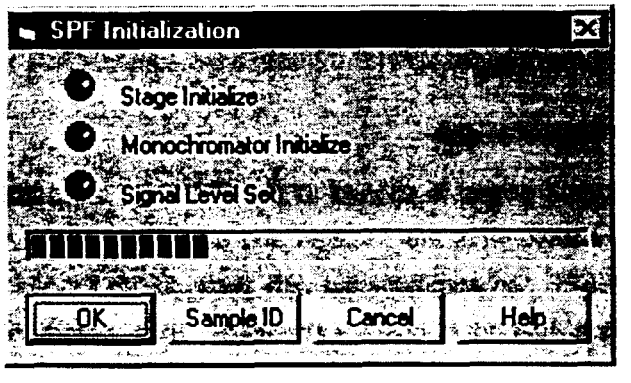


Figure 34 - SPF Initialization

The **H.V.** (high voltage) potentiometer provides a course signal level adjustment while the **Gain** potentiometer allows finer control. Once a reasonable setting has been achieved, lock the high voltage potentiometer and make future adjustments with the gain potentiometer. As the lamp ages, the high voltage potentiometer can be adjusted to achieve adequate performance.

At the conclusion of initialization, the red indicators in the initialization icon change to green as an indicator that the initialization has been completed. There may be occasions when the user has been performing other operations prior to making a sample measurement. Then, in

preparation for making a measurement one might try to proceed through the **Sample ID** form without ever having initialized. If such is the case, neither the **Reference Scan** nor **Run Sample** command buttons are enabled and the measurement cycle seems to be stalled. Check the initialization icon and perform the function if necessary.

Generally, initialization is required only at start up. However, conditions can occur that require the procedure to be repeated.

- The **Esc** key on the SPF-290 computer's keyboard functions as an emergency stop button for the motors. However, because it is an "emergency" the motors are stopped without regard to current operations and position information may be lost. Thus, if the **Esc** key has been pressed, the user is prompted to repeat initialization before proceeding to other operations involving the Monochromator or stage. Note: The initialization icon's indicators will change back to red once the emergency stop command has been used.
- For stable operation it is best to allow the SPF-290's lamp to warm up approximately 15-20 minutes before taking measurements. This allows the lamp output to stabilize. However, if the lamp output drifts beyond acceptable limits, WinSPF notifies the user and opens the signal level setting procedure. Any measurements that were underway when the error occurred must be repeated from the beginning because settings will have changed.

  Note: With proper warm up, the lamp output is very stable. Generally the lamp output noticeably increases during the first few minutes of warm up and gradually stabilizes. Thus, this error will only occur if measurements are started improperly or the sample interacts with the substrate causing increased transmission. Note: In the latter case the signal level should be set to the lower end of the acceptable range.

Identifying the Sample

The Sample ID form is used to input data used for report headers. It also controls a few functions to determine the use of reference scan files. Some fields are automatically loaded with default information that can be changed if necessary.

The **Operator Name** field is automatically loaded with the code or name entered during login. The **Date** and **Time** fields are loaded from the computer and reflect the time at which the Sample ID form was opened. The **Substrate** default is Transpore™. The **Sample I.D.** field can contain any combination of letters, numbers and most punctuation marks. WinSPF checks all

entries to be sure they conform to operating system requirements. The **File Name** and **Reference Name** fields default to the **Sample I.D.** field with a **.spf** and **.ref** extension respectively. If you wish the file names to differ from the sample name, make an entry in the **File Name** field, which will become the default **Reference Name** as well.

The **Reference Scan** command button is disabled unless at least one valid character is entered in the file fields and a setup file is loaded. If a setup file is loaded, the indicator will be green rather than red. If the **Store Reference** box is checked, the reference scan data will be saved to disk when the measurement data is saved.

The **Load Stored Reference** check box allows the user to load a stored reference file from disk for use during the current measurement. It may be that the test process requires a time interval between tests. The user can make a reference scan for a blank sample, store the reference data to disk and then scan the sample. The user may then wish to run another sample set while waiting for the first to undergo some exposure, etc. If the reference scan data is saved to disk, the user can then recall the reference scan data for the first measurement set and make a second measurement set.

When the **Load Stored Reference** box is checked the **Reference Name** field changes from a text entry box to a file list box, showing the reference files stored on the disk. Double clicking a selection will load the file into memory. Simultaneously, the **Store Reference** check box is removed because there is no need of storing a second version of the same data. Loading a stored reference enables the **Run Samples** command button. Because a reference scan is loaded, the next step is to run a sample scan.

The **Comment** field is used to store any user specific information. The comment field can be accessed later if additional comments concerning the run are appropriate.

If **Store Reference** is checked, when closing the form using any command button other than **Cancel** causes the software to check for duplicate reference files on the hard disk. If a duplicate is found, the user is asked to change the file name entry.

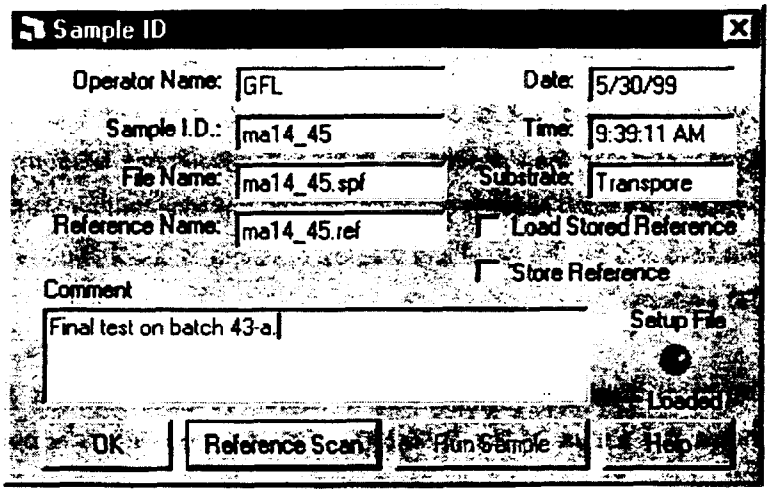


Figure 35 - Sample ID form

Acquiring a Reference Scan

The SPF measurements are ratios of readings with a blank substrate and readings with the product applied to the substrate. The spectral response of the SPF-290 is a product of (1) the spectral output of the SPF-290 lamp, (2) the spectral efficiency of various optical components, and (3) the spectral sensitivity of the detector. Because the spectral response is not uniform a scan of the desired wavelength range must be made and stored in the system memory for later calculations.

Before a reference scan can be acquired sample identification must be completed. Completing the Sample ID form provides a means of acquiring a reference scan. Selecting the **Reference Scan** command button calls the proper procedure. If one exits the Sample ID form using **OK**, there are two other means of calling the reference scan procedure. Selecting  from the WinSPF toolbar or selecting **Reference Scan** from the **Samples** menu also accesses the reference scan procedure.

By whatever means used, the first step is to place a blank substrate in the sample holder as instructed by the software. Selecting **OK** in the message box begins the actual acquisition of the reference scan. The SPF-290 Monochromator moves from its stow position at 180nm to 290nm as the stage (if installed) moves to its first scan location. The data acquisition system then takes several readings as instructed by the **No. of Readings** parameter in the **Sample Setup** form. The time from the start of one reading to the next is controlled by the **Reading Interval** entry in

the same form.

After the reading set is acquired the results are averaged and stored for later use. The Monochromator then moves to the next wavelength (295nm in this case) and repeats the process. As each reading set is completed the resultant average data are displayed in the **Data Window** and on the graphical display resulting in a continuous spectral response for the SPF-290 system.

The main display form has several useful features. The bar along the bottom of the display shows the status of the SPF-290. The left-most panel supplies information on the current procedure. The next panel shows the operating mode. The third panel shows the name of the data file in which the sample data will be stored. The fourth panel is reserved for the time-based mode and shows the time until the stage begins moving to the next scan position. The remaining panels show the current date and time.

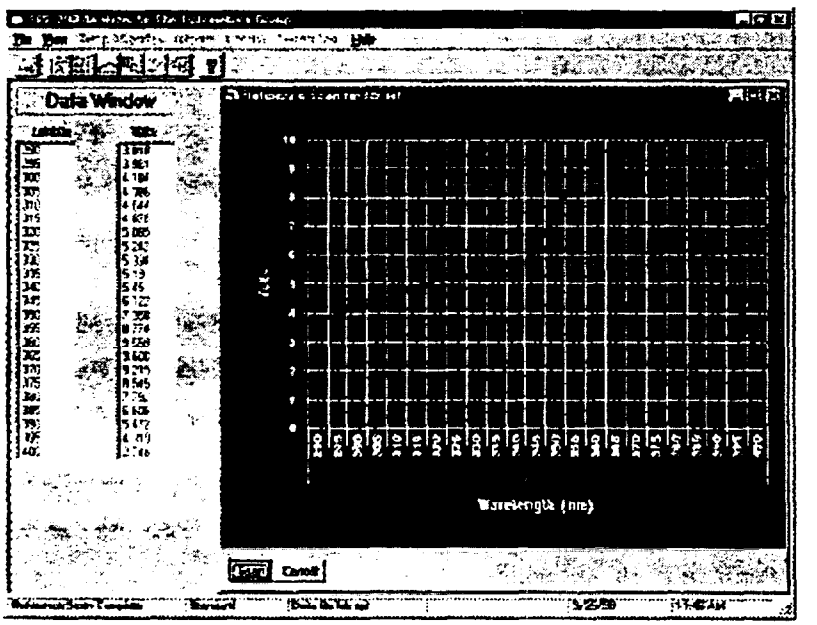


Figure 36 – Reference Scan Display

Acquiring Sample Scans

Preparing Samples

Placing the sample on the Transpore™ tape is a very critical step in the measurement. If care is taken to develop a technique to deposit a uniformly spread sample on the tape, more reproducible results will be obtained. The sample application technique is easily mastered and the reproducibility will increase with practice. It is important to recognize that the technique may vary slightly between individuals. The consistent use of a specific technique will go a long way to ensure reproducible measurements.

Take a sample (110 µl) of the preparation and dab or spot the Transpore™ tape on the sample holder. A 1-cc syringe or a pipettor can be used to dispense 100 or more dabs of sample over an area approximately 3.0 x 2.9" (7.5 x 7.4 cm). The dabs should be spread evenly over the indicated area. This technique will distribute a layer of sample that corresponds to 2.0 µl/cm2 (110 µl/55 cm2), which is the equivalent to the sample thickness used in standard *in vivo* SPF tests.

Note: when the sample is being applied to the Transpore™ tape or spread over the surface, take care not to force it into the aeration holes of the tape. Otherwise minute cylinders (plugs) of sample will effectively increase the thickness of sample under analysis, thus increasing the SPF value. Unlike absorbance measurements, where there is a linear relationship between concentration and absorbance, the change in SPF value due to sample thickness is not linear. To compensate for variations in the sample thickness on the substrate, several scans should be performed on a given sample. After each scan the sample holder will be automatically repositioned by the X-Y stage and another scan will be initiated. Because each scan is displayed on the monitor, an obvious incorrect scan can be easily spotted and removed from the SPF calculation. An MPF scan that is significantly greater than that from other scans of the sample is probably due to the presence of sample cylinders (plugs) that were illuminated by the light source. It should be recognized that small errors due to variations in thickness of the sample are cancelled out.

Note: the uneven surface topography of the Transpore™ tape allows the sample to be applied in a way that approximates the *in vivo* application of the sample to human skin. While the substrate does not anatomically mimic skin, its scattering properties may be responsible for the close agreement between the SPF's determined by *in vitro* analysis and the published values

from *in vivo* tests.

There are three access procedures for acquiring a sample scan. All require that a reference scan be in memory. The most common access is via the reference scan display. A command button at the bottom of the graphical display labeled **Scan** calls the sample scan procedure. The user is instructed to spread the sample on the blank substrate and load the sample holder in the beam or stage.

If a stage is installed, the stage moves to the first stage position and the Monochromator moves to 290nm. A measurement set whose parameters are controlled by the number of readings and reading interval is acquired, averaged and stored in memory for later processing. The Monochromator then moves to the next wavelength (295nm in this example) where more data are acquired. The process is continued until readings at 400nm are completed. The Monochromator then returns to its stowed wavelength of 180nm.

If a stage is installed, the stage then moves to the next location depending whether the fixed grid, random grid or user grid pattern is used and repeats the process until the number of scans parameter is satisfied. If a stage is not installed, at the conclusion of each scan the user is instructed to move the sample to a new position.

Figure 37 shows the display at the completion of a set of sample scans. Several controls have been added to the display. At the bottom of the **Data Window** is a Scan Select control. Clicking the right arrow increments the scan counter and changes the data in the **Data Window** to that corresponding to the scan shown in the **Scan Select** display. By clicking the left arrow the counter is decremented. Thus, the user can review the raw data for all scans.

The graphical display plots the data for each scan in a different color. A legend on the right of the display correlates color to scan number. Note: Microsoft Visual Basic's graphical package is column-based. Therefore, the data point for some wavelength, i.e. 290nm is plotted at the middle of a column rather that on an abscissa ordinate.

The controls at the bottom of the graphical display determine how the data is plotted and gives access to other operating features. From the left, the first three controls change how the current data is plotted. All three controls plot MPF data. The button labeled **LinMPF** plots MPF. The second, **3D**, plots the same data but in 3-dimensional format. The third, label **LogMPF**, plots

absorbance as Log(10)MPF.

The **Ref** command button displays the reference scan being used for calculations. The user can cycle through the four choices at will without causing any changes to the data, etc.

The next two command buttons, **All** and **One**, also control the data display. Currently shown in the **All** mode, the graphical display shows all the scans collected so far. Selecting **One** will graphically display just the data shown in the **Scan Select** display. Cycling the **Scan Select** display with the arrow keys changes the scan displayed in both the **Data Window** and the **Graphical Display**.

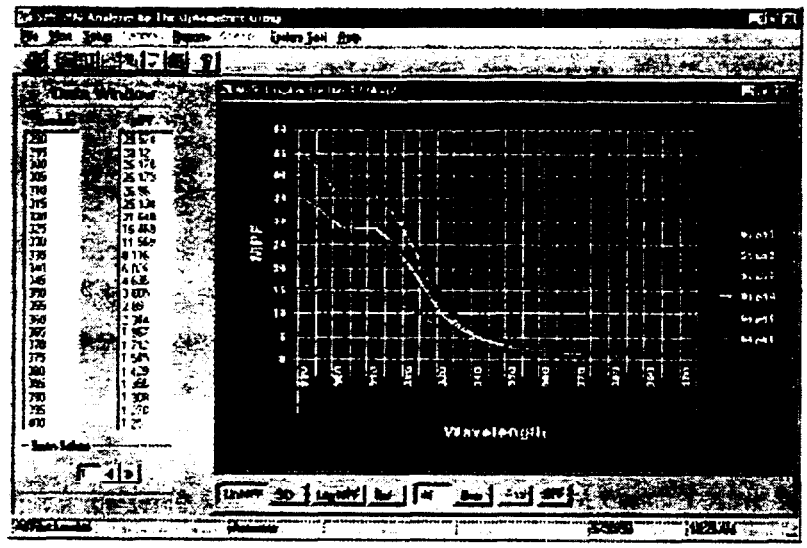


Figure 37 - the Data Window after the completion of a set sample scans

The **Add** command button allows the user to acquire additional scans to the collected data.

The final command button, labeled **SPF** or **T-B** depending on the operating mode, closes the MPF data screen and opens the SPF report display, performing all SPF report calculations.

Once in the SPF report display the user has access to many of the controls familiar from the MPF report. The graphical display controls remain the same. However, one cannot exclude scans in the SPF report graphical display. To review the MPF report, select the **MPF** control at the bottom of the graphical display. Selecting the **Next** control prepares the SPF-290 for

acquiring subsequent measurement runs.

If operating in the Assay pre-link mode, the controls at the bottom of the graphical display are different as shown in the following figure. The user can choose to **Save** or **Skip** the measurement run just completed. Selecting **Save** stores a data file to disk and increments the run counter. If **Skip** is selected, the data for the current run is not saved and the run counter is not incremented.

Once the last run in an assay measurement is concluded and saved the **Save** and **Skip** controls are replaced by **Assay** and **Next** controls. Selecting **Assay** will load an SPF report for the entire assay and **Next** performs the same function as described earlier.

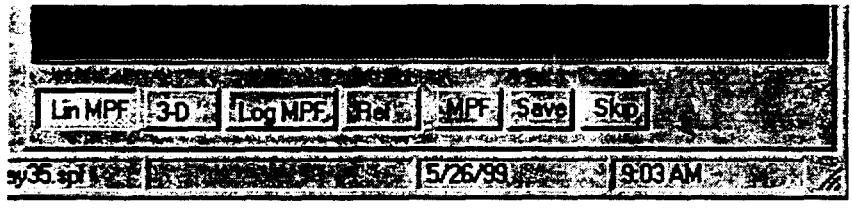


Figure 38 - Close up of Data Window
Action Controls in Assay Mode

Manual Measurements

If an X-Y stage is not installed on the SPF-290 Analyzer, the user must manually move the sample from one position to another if more than one scan/run is selected in the sample setup parameters. It will be impossible to repeat measurements using manual positioning. However, moving to a new location between scans will reduce the chance of sample thickness variations affecting the SPF prediction.

Try to plan a position sequence that provides a good representation of the sample area without repeating scan positions.

Adding Scans

Because samples may not be spread uniformly, sometimes scans may need to be excluded because they are so different from the remainder of the data set. Thus, it may be necessary to add scans to achieve a representative set of scans.

WinSPF can add to the existing scans by selecting the **Add** command button on the bottom of the graphical display. This opens the form shown below.

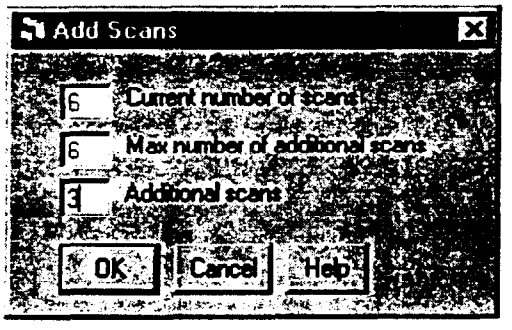


Figure 39 - Adding Scans

The form shows:

- The number of scans that are currently displayed,
- The maximum number of scans that can be added (a total of 12 are allowed), and
- The user's entry of additional scans needed.

Double click the **Additional scans** box and the background will be highlighted. Type any valid number for additional scans and select **OK** to exit the form. Upon exiting, the software checks that the entry is valid and informs the user of mistakes.

WinSPF collects the additional scan data and adds it to reports. Added scans have no special properties. They can be excluded like any other scan.

Excluding Scans

One of the greatest difficulties in making a SPF measurement is the ability to uniformly apply the product to the substrate. The light intensity transmitted through a sample is exponentially related to the thickness of the sample. If the application were perfectly uniform there would be a need for only one scan measurement. However, to ensure accurate SPF predictions it is best to scan at several locations on the sample. The possibility remains that variations in sample thickness may cause large fluctuations in transmission, which may not be representative of the sample. Thus, suspect scans can be eliminated from the calculations. Selecting a scan by either clicking on the plot line or the legend line toggles the line type (from continuous to dotted and back). Dotted lines are excluded from calculations, as shown for Scan 1, below.

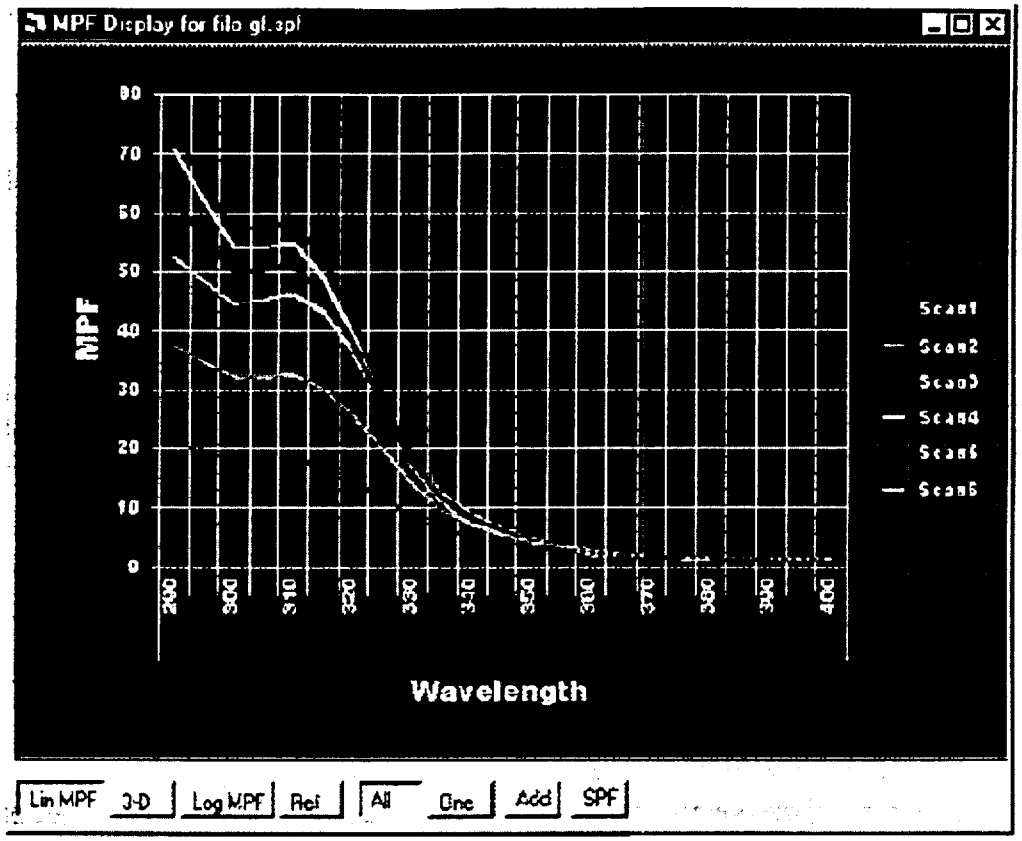


Figure 40 - Close up of Plotted Scans

At no time are the data from the excluded scan eliminated. When the data are stored to disk the data from the excluded scan are included. However, the data file includes a list of the valid scans. Thus, if the run data are reviewed, the calculations, plots, etc. will be identical to the conditions when the data was stored.

Reports

WinSPF provides several reports, both on and off-line. The reports are available whether collecting data or reviewing data from stored data files. To the reporting system the operations are identical. Data are loaded in the computer's memory and acted upon as instructed by the setup parameters and the choices of the user.

On-line Reports

- **MPF Report** - The on-line reports consist of an MPF report display showing the tabular and

graphical data for MPF scans. The tabular data can be reviewed individually using the scan select feature while the graphical display can show either the individual or collective scan data. The window used for the MPF report also serves as the user interface for various other operations such as spectra display, editing, etc. In this case the **Data Window** displays spectral response and the graphical display shows the same data in graphical form.

- **SPF Report** – The SPF report differs slightly according to the mode in which the SPF-290 is operating. However, the basic format remains the same. Report header information, such as sample name, date and time the data was taken, etc., computed results of the measurement run, such as SPF, UVA/UVB ratio, etc., and the average MPF for the run are displayed on the left side of the window under the SPF Data heading. The right side is a smaller graphical display showing all the MPF scans in the run as well as the average MPF for the scans.

  While collecting the data for a pre-linked assay measurements, the SPF report shows the data for the set of scans just completed. After the full set of run data is collected, the SPF report shows the assay data, which is a summary of the runs in the assay.

  In the time-based mode the graphical display shows a computed measurement vs. time. The remainder of the data in the report is very similar to that displayed for other modes.

Off-line Reports

There are three basic off-line reports that can be printed on the system printer. Again, depending on the operating mode, the reports can contain slightly different information but assume the same basic form.

- **Summary Report** – The **Summary Report** prints the results shown in the SPF Data form with some additional header information. The tabular average MPF data are printed in the form currently displayed in the SPF report. Therefore, if Log MPF data is selected, Log MPF data are printed. Additionally, the report shows key measurement parameters. The parameters indicate what type of calculation method was used, which operating mode was used, and other key information depending on the operating mode.

- **Detail Report** – The **Detail Report** contains more information about the measurement run. The top of the report is identical to the **Summary Report**. However, the individual Scan MPFs are displayed rather than the average MPF. For assay measurements, the run data

that make up the report are also displayed along with the linked files used in the report.

- Graphical Report – The **Graphical Report** contains the same header information as the other two off-line reports. Additionally, the report prints a copy of whatever graph is currently displayed. Thus, the user can print the reference scans, linear MPF, log MPF or 3-D view of the data. The graphical data is sent to the printer in color. If the printer cannot print color, it interprets the color as line types according to its capabilities, which are totally independent of WinSPF.

Printing Reports

To print a summary report either select from the toolbar or select **Print Summary Report** from the **Reports** menu. For other reports, select from the **Reports** menu.

Printed reports can also be provided for data stored on disk. Use **Data Review** and print as described above.

Review Comments

Normally, user comments are added during sample identification. However, if after the data are collected for a sample, the user wishes to add more comments or edit existing comments one can do so by selecting **Review Comment** from the **Reports** menu under the **Format Report Data** heading. The comment applies to the currently loaded data. Therefore, it is very important to recognize when appropriate changes should be made.

The entries into the comment text box in the **Review Comment** form are written to the comment text box of the current **Sample ID** form. The comment is then written to the SPF-290 computer's hard disk when the run's data are stored using the **Next** command from the SPF data screen. If a comment is added after the data are saved, the comment will appear in the successive Sample ID's comment text box.

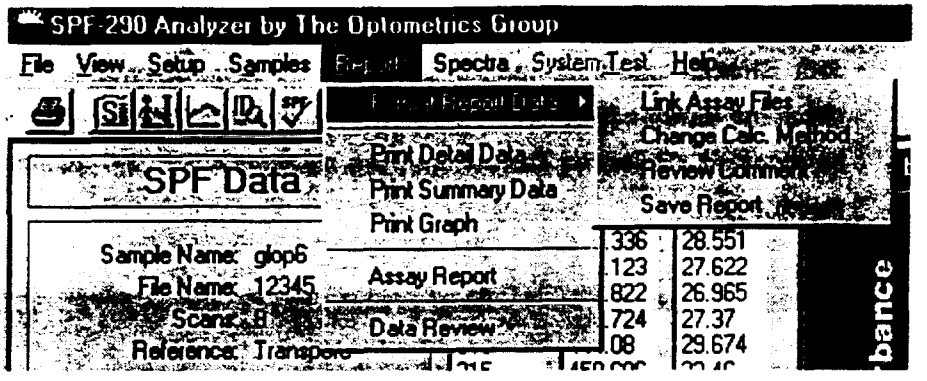


Figure 41 - The Reports Menu

Saving Data

Two methods are available for saving data. Data can be acquired by taking sample scans and computing various properties of the sample. Data or reports that have been loaded into memory for data review can also be saved.

After sample data is acquired the user can select the **Next** command button while in the SPF report display. A form is displayed with options for concluding the run. If **Save** is chosen the data are saved using the data file name entered in the Sample ID form. The user is notified that the data has been stored and the path to which it was saved. In this case, the data are always stored in the **[Install-Path]\data** directory.

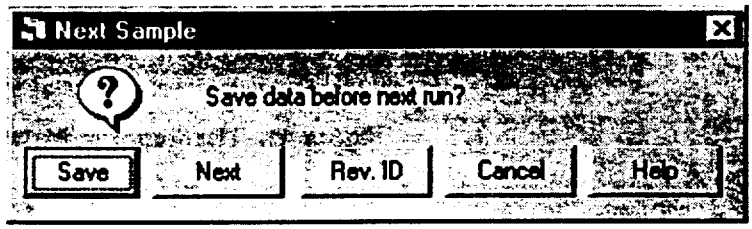
If one wishes to store the data to any other location, the user can select **Save Report** from the **Reports** menu. The file dialog box is displayed for the user to overwrite the previous report, enter a new file name or change the drive and directory where the data are saved.

Concluding a Sample Scan

Selecting **Next** from the SPF report is the first step in terminating the current measurement run. The form shown below is displayed with various options. The **Save** command button stores the current report data to disk using the file name supplied in the Sample ID form. The software notifies the user when the storage operation has been completed, and shows the full path and file name.

The save operation also checks for duplicate files in the **[Install-Path]\data** directory. If a duplicate file exists, the user is notified with the options to **Overwrite**, **Change** or **Cancel**.

Selecting **Overwrite** destroys the contents of the existing file on disk and replaces it with new data. **Change** opens the Sample ID form so the user can enter a new data filename. Selecting **OK** in the **Sample ID** form returns control to the **Next Sample** form where a **Save** attempt can be repeated. Selecting **Cancel** ends the save operation and returns control back to the **Next Sample** form.

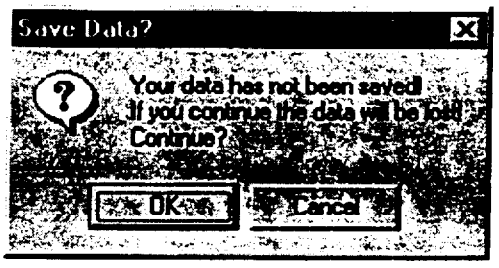


Skipping to the **Next Sample** form's **Cancel** command button, this selection closes the form and returns control to the SPF report command buttons.

The **Rev ID** Button can be used to make last minute changes to the data in the Sample ID form. Here the user can make changes to the file name, comments, etc, prior to saving the data to disk.

Depending if the data has been saved or not, selecting **Next** causes different actions. If the data has been saved, the form closes and the Sample ID form is loaded in preparation for the next sample measurement. This action unloads all the data from memory, resets the displays, and enables menus and toolbar icons as required. The Sample ID form contains much of the same information as when it was originally filled out. The only change is that the time and date fields have been updated to reflect the current time. The assumption is that one may need to change but a character or two of the **Sample I.D.** or **File Name** fields before performing the next sample run.

If the data has not been saved when **Next** is selected, a warning message is displayed, as shown below. If the choice is **OK** the data in memory is unloaded, the form is closed and the Sample ID form is displayed, ready for the next measurement. **Cancel** closes the form and returns control to the command buttons on the **Next Sample** form.


Save Data?
Your data has not been saved!
If you continue this data will be lost!
Continue?
OK
Cancel

System Test

The system test procedure is provided so the user can periodically check the condition of the SPF-290. Some components have finite life times and when not performing optimally, can degrade the performance of the SPF-290. Thus, it is important to periodically perform the test so that problems can be averted.

The test commences by acquiring a reference scan of a blank sample substrate. The optical throughput of the system is recorded and checked against minimum acceptable limits. The test results are then written to a file to be reviewed and, if desired, studied for trends, etc.

Performing a System Test

A system test is begun by selecting from the WinSPF tool bar or selecting **Test Log** from the **System Test** menu.

Displayed in the upper part of the form are the results of the previous system tests. Most fields are self-explanatory. **STDV** shows the standard deviation for the SPF measurement. The **Filter** field indicates which of two neutral density filters was used in the test. The **Lamp** field displays a voltage proportional to the system optical throughput at 290nm.

The optical throughput is the product of (1) the lamp output, (2) the efficiency of system's optical components and (3) the sensitivity of the photo detector. Unless the system is operated in an environment such that the optical components become coated with airborne dust, chemicals, etc., the component that will most likely contribute to the decrease system throughput is the lamp. The lamp output decreases with use and is a function not just of time but also of on-off cycles. Thus, when the voltage read by the detector is below a pre-defined level it is usually a signal that the lamp requires replacement.

If the measured voltage at 290nm drops below 0.8 volts, a warning message is displayed to the user. Note that it is assumed that the test is performed with a blank Transpore™ substrate in place.

To perform a system test select **Test** from the **Test Log Form**. The user is instructed to load a blank substrate in preparation for a reference scan. Unlike other measurement cycles, when the reference scan is completed the stage does not return to the typical load position but remains at

stage position 7. The user is then instructed to load the neutral density (ND) filter into the beam. Be sure that the filter is centered in the beam such that the edges of the filter do not occlude the beam. Otherwise, the system throughput will appear lower than expected.

After the test is completed the **Test Log Form** is displayed again. The data shown in the upper half of the form will include the test just completed as the last item. If the results are satisfactory one can exit the form by selecting **OK**. However, it is also acceptable to repeat the test.

Selecting **Print Test Report** from the **System Test** menu will print contents of the test.log file. Depending on the frequency of testing the system, the file can be large. Thus, it may take some time to print. It may be appropriate to remove records from the file using a standard text editor.

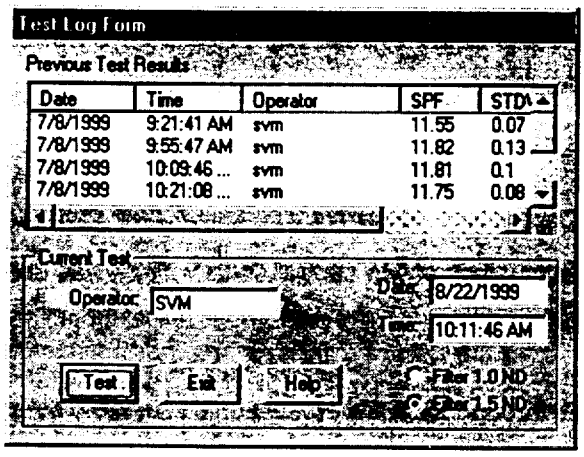


Figure 42 - Test Log

Data Review

As each sample run is completed the user can choose to save the data to disk. If saved, the data are written to disk as comma delimited ASCII text that can be imported into a spreadsheet, etc, for special analysis. The data files can also be reloaded into WinSPF for review and minor changes involving calculation methods or using different collections of scans.

When loading a data file for review WinSPF also loads the sample setup file that was used while collecting the data, and the erythemal and solar response files used in calculating SPF. The sample setup file and the spectra files are loaded in their current state. If the user has made changes to the setup file since the data was collected, with few exceptions, WinSPF cannot accommodate the changes.

The sample setup file is less critical than the spectra files in that much of the setup parameters deal with collecting the data and that task is already completed. Additionally, parameters, like number of scans, are included in the data file header and are forced on the setup file.

However, if the original setup file was for a time-based measurement and the setup file has been changed to standard mode, the SPF report will be displayed incorrectly. Therefore, it is best to create sufficient numbers of setup files so one is not required to make changes.

There is no recovery for altered spectra files. If the user has changed the spectral response and not saved the file using a new file name, the SPF calculated the second time might differ from that included in the data file header. To ensure this doesn't occur, when editing a spectral response curve assign a new file name when saving.

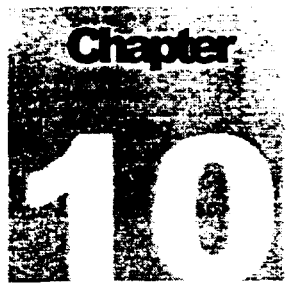
Loading Old Data

Load a data file for review by selecting **Data Review** from the **Reports** menu. The selection opens the file dialog box showing all data files stored to disk. Selecting a file will (1) load its contents into memory, (2) load the corresponding setup and spectra files into memory, (3) make the necessary calculations, and (4) display the final report.

The user can then click into MPF display mode for review and to make changes.

Changes to Old Data

Although it is not recommended unless an error was made prior to collecting the sample data, changes can be made to stored data files. Under no conditions other than using a text editor on the data file can changes be made to the actual data. However, one can change the method of calculating SPF standard deviation and can change the excluded scans used in the final report, review the results of the changes and store the changed report to disk.



File Structures

All files used by WinSPF are in ASCII (text) format so they can be read by any text editor, word processor, etc. and can be imported into spreadsheet or database programs. When used properly, this is an advantage. The user can look at trends in the SPF-290s lamp output by checking the data in the system test log for example. However, because the files are so accessible, they are susceptible to contamination if the user intentionally or accidentally makes changes to the contents.

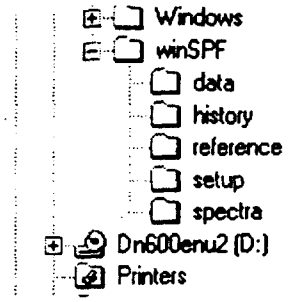
Files Used or Generated by WinSPF

The following is a list of files used or generated by WinSPF followed by a detailed description of each.

- **Sample Setup Files** – files containing the sample measurement parameters.
- **Data File** – files that contain the results of a sample measurement.
- **Assay Link File** – files used in making assay reports.
- **System Test Log** – data stored after a system test procedure.
- **Reference Scan File** – files for stored reference scans.
- **Spectra File** – solar and action spectra files used in calculating SPF.
- **Error Log File** – a file containing entries that are added any time a system error occurs.
- **SPF Init File** – file used to start WinSPF.
- **DAS Init File** – file required to initialize the DAS-8 data acquisition board.

Directory Structure

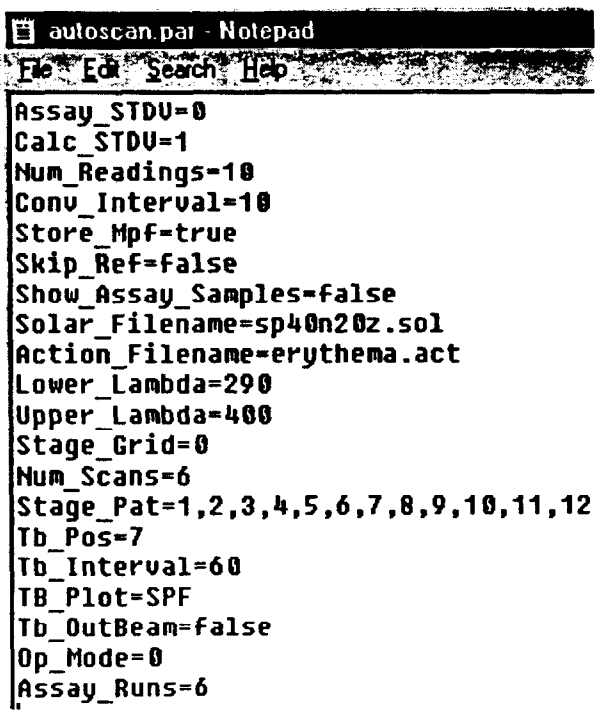
The figure below shows the directory structure for WinSPF and its associated files. The installation directory (Optometrics in the figure) can differ from that shown. By default, Windows setup uses **C:\Program Files**. However, the remaining folders are storage locations for various files associated with WinSPF regardless of where the application is installed.



The WinSPF executable file, WinSPF.exe, is located in the WinSPF folder. The **SPF.ini** and **KMBDAS8.ini** files, and custom WinSPF DLLs (dynamic link libraries) are located in the **\Windows** or **\Windows\System32** folder depending on the operating system installed on the SPF-290 computer. The **data** folder is where all the data files are stored. The **history** folder includes the Error.log and the test.log files. The **reference** folder is where all reference scans are stored. The sample setup files are located in the **setup** folder while the **spectra** folder includes the solar irradiance and erythemal action files.

Sample Setup Files

Not to be confused with older SPF software setup files, WinSPF uses file names with a **.par** extension for sample setup files. The files are stored in the **\setup** directory under the application **[install_path]** directory. The contents of the file are shown below.



Although this particular setup file is for the standard mode of operation it contains default parameters for both the assay and time-based modes. However, based on the Op_Mode value, parameters are ignored or used as necessary. The next page shows a brief description of parameters.

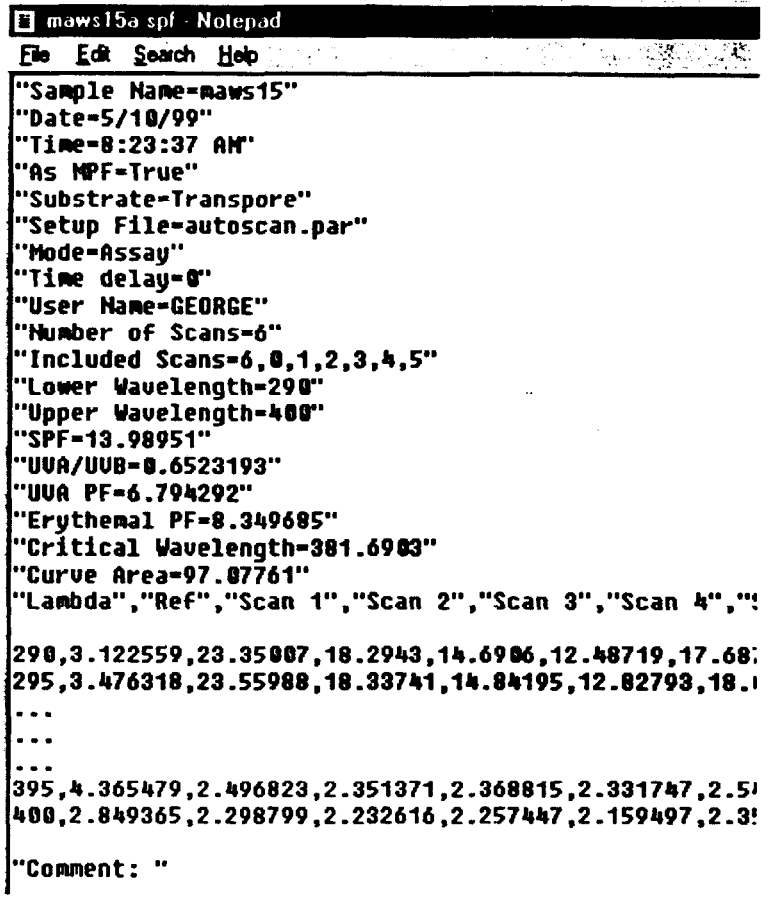
Parameter	Description	Value
Assay_STDV	Determines which method is used for calculating the STDV in the assay mode	0=STDV using scans 1=STDV using runs
Calc_STDV	Determines the method used to calculate SPF STDV	0=Diffey 1=Classical
Num_Readings	The number of readings taken by the data acquisition board at each wavelength.	2 – 20
Conv_Interval	The interval between data acquisition board readings in msec.	.5 – 65
Store_Mpf	Determines if the data are stored as a voltage or MPF.	True = MPF False = Voltage
Skip_Ref	Determines whether or not to acquire reference scans for successive samples while in the assay mode.	True = Skip ref. Scans False = Get ref. Scan for each sample
Show_Assay_Samples	Determines if scans or runs are displayed when displaying graphical assay reports.	True = show all scans False = show only run means
Solar_Filename	Shows the name of the solar irradiance file that will be loaded for the sample run.	Any valid file name with a .sol extension.
Action_Filename	Shows the name of the skin response file that will be loaded for the sample run.	Any valid file name with a .act extension.
Lower_Lambda	The wavelength (nm) at which a set of scans will start.	290
Upper_Lambda	The wavelength (nm) at which a set of scans will end.	400
Stage_Grid	Determines which of three modes are used if a stage is installed	0 = Fixed grid 1 = Random grid 2 = User selected grid
Num_Scans	The number of scans included in each run.	1 - 12
Stage_Pat	The sequence of stage positions for the user defined mode.	Any series of numbers between 1 and 12.
Tb_Pos	The stage position where time-based measurements will be taken.	1 – 12
Tb_Interval	The time (sec.) between successive time-based measurements	Min. calculated by system, max.=3600
Tb_Plot	Which data are plotted in the SPF report graphical display.	SPF CumAbs
Tb_OutBeam	Determines if the sample is in or out of the beam between successive time-based scans.	True = out of beam False = in beam
Op_Mode	Which of three operating modes are selected.	0 = Standard 1 = Time based 2 = Assay
Assay_Runs	The number of runs included in an assay measurement.	1 - 12

Data File

The data files are stored in the **\data** directory under the **[install_path]** directory. The files names are those given in the Sample ID field of the **Sample ID** form. For a standard data file the file extension is **.spf.** For pre-linked assay files the file extension is **.sp[n]** or **.s[nn]** where n is a numerical value signifying the order that the files were created for an assay set.

Files with a **.lnk** extension contain the file names that make up an assay set. If the assay report was pre-linked, the file name extensions will include numbers as described above. File names in a link file without numbers were post-linked. Files with the extension **.asy** are for assay reports.

All files are in ASCII text form so they can be easily imported into databases or spreadsheets so custom reports or analysis can be generated. The following is a sample data file with some of the data removed.



maws15a spf - Notepad

File Edit Search Help

```
"Sample Name=maws15"
"Date=5/10/99"
"Time=8:23:37 AM"
"As MPF=True"
"Substrate=Transpore"
"Setup File=autoscan.par"
"Mode=Assay"
"Time delay=0"
"User Name=GEORGE"
"Number of Scans=6"
"Included Scans=6,0,1,2,3,4,5"
"Lower Wavelength=290"
"Upper Wavelength=400"
"SPF=13.98951"
"UVA/UVB=0.6523193"
"UVA PF=6.794292"
"Erythemal PF=8.349685"
"Critical Wavelength=381.6903"
"Curve Area=97.07761"
"Lambda","Ref","Scan 1","Scan 2","Scan 3","Scan 4","
290,3.122559,23.35007,18.2943,14.6986,12.48719,17.68
295,3.476318,23.55988,18.33741,14.84195,12.82793,18.
...
...
...
395,4.365479,2.496823,2.351371,2.368815,2.331747,2.5
400,2.849365,2.298799,2.232616,2.257447,2.159497,2.3

"Comment: "
```

Most of the fields in the file header are clear. However, a few require further explanation.

- **As MPF** – This string informs us how the data was stored. If "False" as shown, the scan data was stored as a voltage. If the statement was "As MPF=True", the data was stored as MPF.
- **The mode** keeps track of what operating mode was used while data was collected. The options are Standard, Assay and Time-based.
- **The Time delay** is used to hold the value for the interval between time-based scans. This value is used when the data file is reviewed to display time-based results.
- **Included Scans** – This string tells the user and WinSPF which scans are included if the report is loaded back into WinSPF for review. The first number is the total number of scans that are included. The remaining numbers are computer code for the scan numbers that are included in the SPF calculations. Computers are zero based while we commonly think of lists as one based. Therefore, the "0" in the **Included Scans** string really refers to Scan 1 further in the file.

As shown, all the scans are included in the sample run. However, if Scan 3 were excluded, the string would read as follows: "Included Scans=5,0,1,3,4,5".

- The **upper and lower wavelength strings** are included for possible software enhancements.
- The line beginning with "**Lambda**" is the heading for the data columns. Although the headings and columns do not line up in the file, when imported into a spreadsheet in comma delimited format, alignment will be achieved.
- **Headings and columns** are included for the maximum allowable number of scans. If the data is "0", no data was acquired for that particular scan.
- The "**Comment**:" line can contain a descriptive string that was created in either the Sample ID form or **Comment** form under **Reports**, **Format Report Data**.

Assay Link File

The assay link file contains a list of the data files included in an assay report. The link files have a **.lnk** file extension. Unfortunately, Windows operating systems interpret the .lnk extension as a shortcut file. Therefore, the files can not be opened from Windows Explorer using an associated application. However, the file can be opened directly using any text editor.

System Test Log File

The system test log file contains the history of the results of performing a SPF-290 system test. Each time a test is performed the results are written to test.log located in the **\history** directory under the application **[install_path]**.

The file is structured to be loaded into a spreadsheet using a comma-delimited format. The user can then perform analysis of the data if so desired.

The first line is a heading describing the contents. Data and time are provided by the operating system and indicate when the test was made. The operator is the person who performed the test. This might be different from the login name. The data in the SPF column is the calculated SPF measured during the test. STDV is the standard deviation for the SPF measurement. The filter indicates which of two neutral density filters were used during the test. Finally, the lamp output shows the SPF-290 system throughput at 290nm. For best performance, when the lamp output reading drops below 0.8 volts the lamp should be replaced.

The test log file can be used as a tool to keep track of any changes to the SPF-290. For example, if the system has been serviced, open the file with a text editor and make a note of the date and what was done. Then, when results are analyzed reasons for sudden changes in SPF, etc. can be understood.

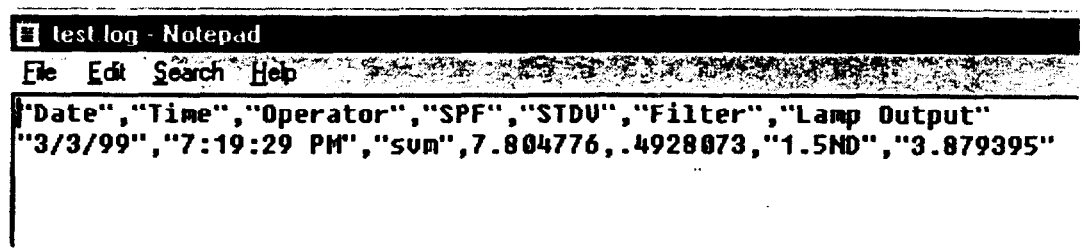


Figure 43 - Test Log

Reference Scan File

The reference scan files are located in the **\reference** directory under the **[install_path]** for the application. The files consist of two comma-delimited columns of data. The first is the wavelength in nm while the second column is the voltage output from the system at that wavelength.

Spectra File

The spectra files are located in the **\spectra** directory under the application **[install_path]**. Both spectra files consist of two comma-delimited columns of data. The first column is the wavelength while the second corresponds to the value at that wavelength. In the case of the solar response the value represents the solar irradiance in Watt/meter2/nm.

The erythemal effectiveness data is unit-less and conforms to CIE S 007/E-1998: Erythema Reference Action Spectrum and Standard Erythema Dose.

Error Log File

The directory **[install_path]\history**, located under the WinSPF installation directory, contains historical reports for the SPF-290 system. One of the files included in the directory is **error.log**. Each time WinSPF is used a message is appended to the file providing the date, time, user

sign-on code and the software revision. Each time the user closes the software a message is also logged showing date and time. The file is in ASCII form so that it can be imported into other programs to be used for analysis and troubleshooting.

Should an error occur, a message is also appended to the file. A sample error message and explanation follows:

> ***Started: 3/24/1999 6:18:12 PM by SVM Ver. 1.0.2***
>
> ***"Err:","SPF_motor.bas","comm_init()",12,8018,"Operation valid only when the port is open",SVM",03/24/1999 6:52:16PM, "Build: 1.0.2"***
>
> ***Normal shutdown: 3/24/1999 6:53:45 PM***

The second line above is the error message as indicated by the "Err:" code at the beginning of the line. After the code, the comma-delimited data provides the following information:

- {SPF_motor.bas} Module where the error occurred
- {comm_init()} The function in which the error occurred
- {12} The line number in the code where the error occurred
- {8018} The error code returned from one of several potential sources
- {Operation valid.....open} A description of the error
- {SVM} The login code
- {03/24/1999 18:52:16} The date and time that the error occurred
- {Build1.0.2} The software build version.

SPF.ini File

The SPF.INI file contains information WinSPF uses at startup. It is located in the **\Windows** directory. As shown, the file contains the registered user name, the serial number for the software and the registered company name. This information is used for display purposes. Entries must exist otherwise the user is prompted to provide information each time the software is loaded.

The next four entries under the [Hardware] heading describe (1) the model name of the data acquisition board installed in the SPF-290 computer, (2) the address of the data acquisition board (3) the serial port to which the SPF-290s is connected, and (4) the current setting for the stage speed. The **Dac_Addr** is shown as a decimal number. In the hardware setup form and the registration form the choices are shown as hexadecimal numbers, the numbers preferred by

computers. The address listed as 768 in decimal is 300 in hex notation.

The final entry under the [Setup] heading is the setup file name that is loaded when WinSPF starts.

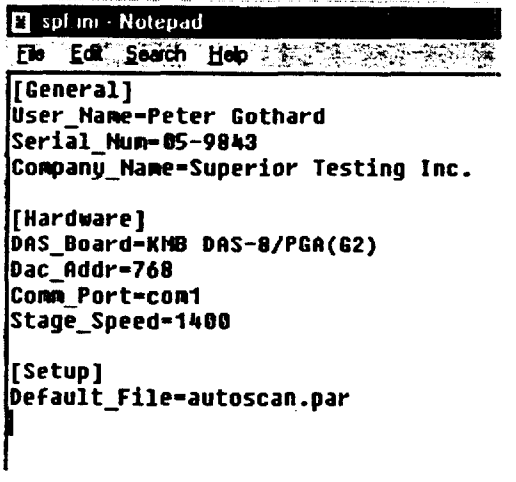


Figure 44 - SPF.INI file

DAS File

Let's clarify some terminology before we continue. In other parts of this manual the data acquisition board has been called a DAC (Data Acquisition Card). The DACs used in the SPF-290 have names beginning with DAS (Data Acquisition System). Both DAS and DAC refer to the same device.

Two models of data acquisition boards are used with the SPF-290. A Keithley Instruments DAS-8/PGA-G2 board is used for older SPF-290s. This product has been rumored to be going out of production for many years but is still available as of this writing. However, the DAS-8 is not supported to operate under Windows NT. Keithley Instruments also supplies an upgraded version of the DAS-8 called the DAS-802. The board is register and pin-out compatible with the DAS-8, and can be used as a replacement.

DAS-8/PGA-G2

One difference in the software implementation between the two boards is how the hardware and software configuration data are communicated. With the DAS-8 the software opens a file stored on disk, reads the file's contents and uses the information to determine how to communicate to

the board. The file is located in the **c:\Windows** directory and is called **KMBDAS8.INI**. The file contents are as follows:

[Device 0]
Vendor = Keithley MetraByte
Model = DAS-8PGA
Address = 768
A/D Channels = 8
Min A/D volts = 0
Max A/D volts = 10
IRQ = -1
DMA = -1
Clock = 1.0 MHz

The contents of the file can be altered using any text editor. However, changes are not recommended. Invalid entries will cause the SPF-290 to be inoperative.

During software installation or when using the hardware configuration form, WinSPF controls entries in the .INI files. If the user changes the DAC Address from the default of 300 HEX, the new value is translated into decimal notation and written into the "Address=" field. Note: one cannot arbitrarily change the address in the software. The board must be switch configured to the same address for the software to be able to locate the board.

One possible need for altering the file contents exists in the very unlikely event that none of the addresses available in WinSPF are free of hardware conflicts. If hardware conflicts are suspected, use Windows utilities to identify the conflict. If after trying all standard SPF-290 addresses a conflict remains, contact Optometrics for instructions.

DAS-802

The DAS-802 board is configured within the operating system and has no auxiliary file containing configuration information.

Service, Maintenance and Troubleshooting

The SPF-290 has been designed for trouble-free operation. However, if a difficulty should arise in operation, follow the problem determination procedure in this section. If a major problem is found, complete the Return Report on the last page of this manual and contact the service department for a Return Authorization Number prior to returning the instrument or any parts according to the Warranty and Return Policy found at the end of this chapter.

Hardware Start Up Problems

If during WinSPF startup, the SPF-290 does not operate correctly, begin by reviewing the following symptoms and checking the indicated items.

No Power to the analyzer or computer:

- Check that the AC power line is firmly plugged into the input module receptacle of the analyzer and into the wall outlet supplying power.
- Check that the computer power cord is firmly plugged in to the computer power receptacle on the back of the analyzer and on the back of the computer. The computer switch should be turned to "ON".
- Check that the input voltage is correct and that no fuses are blown.

Xenon Lamp is on but the fans are not operating:

- Switch off power immediately. The Xenon lamp will be damaged without an operational fan.

Xenon Lamp is pulsing 2 to 3 times:

- Switch off power, then turn it on again.

Xenon Lamp is not operational after replacement.

- The Xenon lamp power supply is not functional. Return the analyzer to Optometrics for service.

Software Startup Problems

During software registration, hardware configuration data are entered in a form along with user information. The hardware configuration is essential for correct communications between WinSPF and the SPF-290 hardware. Minor tasks are performed during registration to ensure that the Comm Port entry is valid for your computer.

As WinSPF starts a splash picture is displayed that shows the name of the software, revision, user name, etc. If the following message box is displayed and you feel the SPF-290 hardware startup problems have been addressed, it could be that incorrect information was entered in the registration form. Select **Ignore** from the command buttons to bypass the communications test and start the software in demo mode.

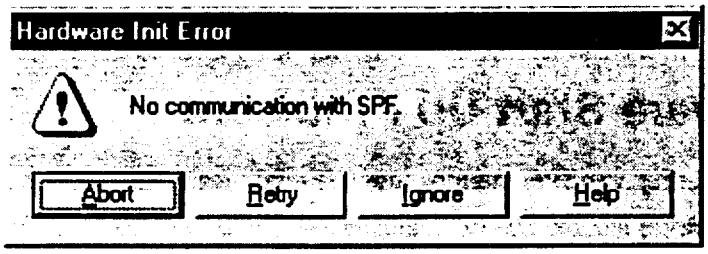


Figure 45 - Hardware Error Warning

Use the hardware setup feature to configure the hardware. Once the communications and initialization are satisfactory, restart WinSPF. If the stage chatters during stage initialization, turn off the SPF-290 power, the stage controller power and exit WinSPF. Then, turn on power to the SPF-290 and stage controller, and restart WinSPF.

Problems During Analysis

If a problem occurs during an analysis run, the problem may be due to a failure in any of the following:

- Analyzer,
- Computer hardware,
- Computer software, and/or
- Analyzer/computer interface.

If an error message is reported via a Windows message box or in the error.log file, refer to the Error Message section for more details.

If the error message indicates communications problems, check that the computer's serial port is operational using Windows tools, and, if the port is OK:

- check installation of analyzer/computer RS-232 interface cables,
- ensure that all cables are firmly in position, and

- check for cable continuity.

If the software produces no start-up errors, but (1) indicates a bad signal error during Monochromator initialization, and (2) adjustments to the H.V. and Gain potentiometers produces no change:

- check the data cable between the SPF-290 and the data acquisition board,
- ensure that all cables are firmly in position, and
- check for cable continuity.

If during a reference scan the data is 0 but the system passed initialization:

- check the data acquisition board cable, and
- check that the light beam is not blocked.

If during a sample scan a divide by zero error occurred but the system acquired a valid reference scan:

- check the data acquisition board cable,
- check that the beam is not blocked, and
- be sure the sample can transmit at least .01% at 290nm.

If the output of the Xenon lamp is low as indicated during the system test, it is recommended that you replace the xenon lamp.

Check to ensure that all operation procedures and the sample application method is correct.

WARNING: There are no customer serviceable parts inside the analyzer with the exception of the Xenon lamp. Any attempt to disassemble the analyzer may expose the user to high voltage and/or alter the alignment. The warranty will be voided if the unit is disassembled.

X-Y Stage Problems

The SPF-290 X-Y stage is a precision mechanism that requires careful assembly because of its close tolerances. As the stage wears or its mechanism becomes dirty, its performance can suffer. Recent design improvements have enhanced performance under all conditions, allowing the stage to operate at greater step rates yielding shorter scan times. However, because WinSPF must operate with all versions of the X-Y stage, the software provides various motor

speed options to provide optimum performance.

If the stage does not move reliably, it could be that the gears are worn or dirty, or, in the case of a new SPF-290, there was some change in alignment during shipping. In most cases decreasing the stage speed can improve reliability.

Use the **Hardware Configuration** form to select an alternate stage stepping motor speed. As shown below, four options are available. Selecting an option and then selecting the **Stage** command button exercises the stage. First, the stage will initialize to find "home". Then it will cycle through all 12 stage positions at the selected motor step rate. Once satisfied with performance, select **Save** to store the setting for future use.

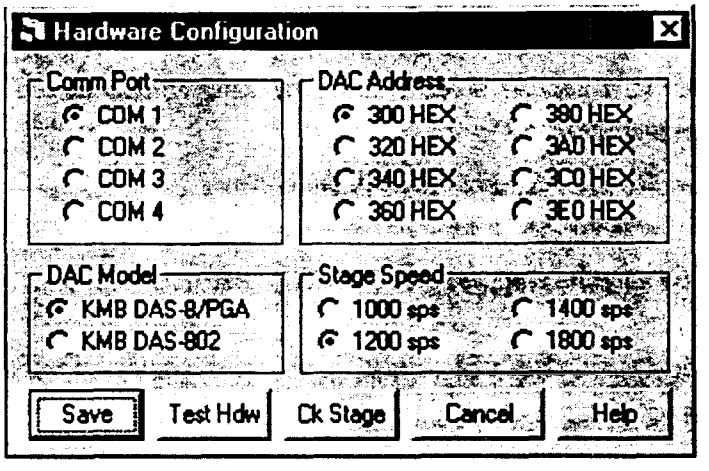


Figure 46 - Hardware Configuration

Lamp Replacement Options

The operator has two options with respect to changing the lamp:

- Replacing the lamp and heat-sink, and
- Replacing the lamp.

The old lamp-heat-sink assembly may be reusable. Call Optometrics to inquire about receiving credit for returning the old heat-sink assembly.

To minimize the down time involved with lamp replacement, it is recommended that a few spare lamps or spare lamp / heat-sink assembly be kept on hand. Ordering information can be

S6063-0015-2	Motor/limits cable
S6066-0040	UG-5 Filter
S6066-0051-1	Calibration ND filter (1.0 OD)
S6066-0051-2	Calibration ND filter (1.5 OD)
402-0014	Fuses
390-0009	Data Acquisition Board
451-0018	X-Y motor / limits cable
6070-0051	Y-Split RS-232 Cable

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Warranty

Statement of Warranty

Optometrics warrantees the SPF-290 Analyzer against defects in materials and workmanship for one year from the date of purchase with the exception of the xenon lamp, which is warranted by the manufacturer for 500 working hours.

Optometrics is not liable for any consequential or incident damage arising from the sale of its product(s). In any event, liability shall not exceed the invoice value of the product(s) sold.

Accidental damage, neglect, unreasonable use, attempted service, calibration adjustments or cleaning not explicitly called for in this or any instruction manual voids the Optometrics warranty. Optometrics makes no warranty other than described above for its products or for the performance for a specific application.

Non-Warranty Repairs

A Customer Return Authorization number (CRA) is required to return a product for out of warranty repairs. No repairs will be made until you have been notified of the cost and have issued a purchase order to Optometrics. All transportation costs for a CRA are borne by the user. Please make certain that the CRA number is clearly marked on the outside of your shipping container.

Warranty Returns

A Return Goods Authorization Number (RGA) is required to return a product within the warranty period. To obtain an RGA, please call Optometrics and provide:

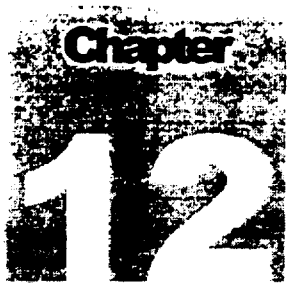
- your original purchase order number,

- date of shipment,
- serial number, and
- a description of the nature of the problem.

If a defect due to material or workmanship is found, the product will be repaired or replaced at Optometrics option at no charge. The transportation cost for returned goods must be prepaid. The repaired or replaced product will be returned at Optometrics expense. Please make certain that the RGA number is clearly marked on the outside of your shipping container.

Restocking Charges

A 15% restocking fee will be charged for all unused returned goods. A CRA is required for all products suitable for restocking. No product(s) can be returned for restocking after 90 days.



Error Messages

One would like to assume that no errors would ever occur in the use of a measurement system. However, the perfect system has yet to be built. The SPF-290 has a fair number of sub-systems that must operate flawlessly to make a measurement, calculate the desired results, display the results for the user and print a report at the conclusion of a measurement run.

Errors can occur in the operating system (Windows™), in the WinSPF specific software, the SPF hardware, and as unlikely as it may be, users can make mistakes. WinSPF is designed to attempt to recover when errors occur. The software traps the error as it occurs, logs the error to disk, generally notifies the user that an error has occurred, provides some options for the user to try to recover, or, in rare cases, forces action by resetting WinSPF.

The following are a list of error messages that are displayed to the user when an error occurs. These messages are generally less verbose than the messages in the ERROR.LOG file. The following sections provide descriptions of possible errors and other messages that may be displayed during operation.

Error Code	Description	Source
5	Invalid procedure call.	Visual Basic
6	Math overflow.	Visual Basic
9	Subscript out of range	Visual Basic
11	Divide by zero.	Visual Basic
52	Bad file Name.	Visual Basic
53	File not found.	Visual Basic
55	File already open.	Visual Basic
57	Device IO error.	Visual Basic
58	File already exists.	Visual Basic
61	Disk full.	Visual Basic
62	Input past end.	Visual Basic
68	Drive Unavailable.	Visual Basic
71	Disk not ready.	Visual Basic
76	Path not found.	Visual Basic
482	Printer error.	Visual Basic
486	Printer won't print form.	Visual Basic
1000	Stage user pattern routine error	WinSPF
1001	Stage random pattern routine error	WinSPF

1002	Stage fixed pattern routine error	WinSPF
1003	Monochromator error during initialization. Failed to find "Home" or zero order.	WinSPF
1004	Stage initialization error. Failed to find "Home" position.	WinSPF
1005	Stage present error. (not currently implemented)	WinSPF
1006	Stage set error. The stage failed to reach its commanded location.	WinSPF
1007	Error in the stage sequence routine.	WinSPF
1008	Error while setting the stage location in time-based mode.	WinSPF
1009	Error in signal level routine or signal level was exceeded during measurement.	WinSPF
1010	Error sending the Monochromator to next wavelength.	WinSPF
1020	DAS failed initialization.	WinSPF
1021	Error acquiring a single DAS reading.	WinSPF
1022	Error setting the DAS gain.	WinSPF
1023	Error acquiring a DAS scan reading.	WinSPF
1024	DAS reading saturated. (Reading above 4095 counts)	WinSPF
1025	DAS reading = zero	WinSPF
1030	Error loading spectra file	WinSPF
1031	Error loading demo file	WinSPF
1032	Error loading setup file	WinSPF
1040	Error loading include scan array.	WinSPF
31036	Error saving to file.	Visual Basic
31037	Error loading from file.	Visual Basic

No Communications with SPF

There are three potential problems that can cause this error message to be displayed. They are as follows:

- The serial port in the SPF-290 computer is defective. Refer to your computer's documentation to determine how this can be determined and resolved.
- The cable between the SPF-290 computer and the SPF analyzer is disconnected or defective. Check that connections are secure and try the software again. Also be sure that the correct cable is being used. If the bifurcated cable is used without the SPF x-y stage this error will occur.
- The Monochromator motor controller is defective. Call the factory for further information.

Stage Communications Error

An error has occurred when WinSPF attempted to initialize the stage motor controllers. The software has determined that the stage controllers are connected but the controller does not accept default setup commands. Refer to the factory for further information.

Data Acquisition Board Error

An error has occurred while WinSPF passed configuration instructions to the data acquisition board. The board was successfully initialized but failed to respond correctly to a service request.

There are four potential causes of this error.

- If the error occurs the first time the software is started after software installation or changes were made to the hardware configuration, there is a potential mismatch between the software driver and the data acquisition board. To correct the problem, go to hardware configuration and change the data acquisition board type. Note, changing the DAC address will not correct the problem. If the board passes initialization, the address is OK.
- If using the DAS-8/PGA-G2 data acquisition board, the .ini file could be corrupted. Again, because the board passed initialization the address is valid. However, some other data is invalid. Check the KMBDAS8.ini file for contents.
- If using the DAS-802 board, the installation could be incorrect or corrupted. Because the installation configuration is written to the operating system registry, diagnosis is beyond the scope of this manual. However, the best approach is to reinstall the driver carefully following the instructions. **Note, it is very important to uninstall the driver before a second installation attempt.**
- The data acquisition board is defective. Contact the factory for further information.

Data File Already Exists

This message is displayed when the user is attempting to use a duplicate file name while saving a data file. Enter a different name in the Sample ID form or delete the older file using Windows tools.

Reference File Already Exists

This message is displayed when the user attempts to use a duplicate reference file name while in the Sample ID form. Only unique file names are allowed. WinSPF will not overwrite existing files. Enter a different file name or delete the older file using Windows utilities.

Load Blank Substrate

All SPF-290 measurements are ratios of the sample transmission to the transmission of whatever material is used to support the sample. Thus, before a proper measurement can be made a reference scan of the sample support substrate is required. Only then can WinSPF calculate the absorbance of the sample.

It is important that the blank substrate be the same as that used with the sample. Otherwise, errors will result unless the substrate material is extremely uniform.

Stage Failed to Initialize

Either the X or Y stage has failed to find its "home" position. Check the following:

- Power has been interrupted to the stage controller. If this occurs the motor controller addresses will be invalid. This may cause the stages to fail to move, move in the wrong direction or move when commands are sent to the Monochromator motor controller. To correct the problem exit WinSPF and cycle the power to both the SPF-290 Analyzer and the stage controller. Then restart the software.
- If the stages move in the proper direction but produce a grinding or chattering noise, there may be a cable or optical switch problem. Contact the factory for further instructions.
- Check that nothing has fallen into the stage mechanism preventing the stage from moving over its full travel.

Monochromator Failed to Initialize

Although the message refers to the Monochromator having failed the source of the problem is the data acquisition board. It is possible that the board can be initialized properly but fail to make a valid reading. Refer to Data Acquisition Board Error for more details.

Signal Level Failed Initialization

This message can only be displayed if the user closes the signal level form without completing the procedure. Thus, choose SPF initialization again and complete the procedure. No further SPF-290 operations can be executed without completing this procedure at start up.

Error Going to Next Wavelength

An error occurred while the Monochromator was being instructed to move to the next wavelength in a scan sequence. The error can only be caused by a failure of the Monochromator stepper controller to accept a command or notify WinSPF that the motor has stopped at the correct position.

Although unlikely, the serial communication between the SPF-290 Analyzer and the SPF computer might have failed. However, this can be determined by restarting WinSPF. The serial port is routinely verified at software startup.

Error Loading Spectra Files

One of several potential errors have occurred while loading the erythemal and/or solar spectra files. The files may be absent or contaminated. Therefore, WinSPF has loaded default files so that measurements can continue. The default files are for solar irradiance in Watt/meter sq./nm for midsummer sunlight in Southern Europe at latitude 40 Deg.N, solar zenith angle 20 Deg. and ozone layer thickness of 0.305 cm.

The erythemal effectiveness data is unit-less and conforms to CIE S 007/E-1998: Erythema Reference Action Spectrum and Standard Erythema Dose.

The spectra file contents for the offending files can be explored using a text editor. The contents should contain 23 wavelength and response values as described in the spectra file section.

Subscript Out of Range

This error indicates that the software has attempted to store more data in an array than is allowed. This usually occurs if the array has not been dimensioned correctly. For it to occur in the contents of the WinSPF software the user must have performed tasks in an unanticipated sequence. Therefore, it is very important that the error message and any additional information be supplied to Optometrics so proper steps can be taken to prevent a reoccurrence of the problem.

Error Setting DAS Card Gain

The data acquisition board uses multiple amplifier gains to maximize signal resolution over a broad range of input voltages. Before each conversion by the board A-D converter, the software tests the input to ensure that it is within prescribed levels. If the conversion result is too high the gain is decreased. If the result is too low, the gain is increased, providing an increased gain level is available.

When this error occurs it indicates that even with the lowest gain the input still saturates the A-D converter (the DAS board output is > 4095 counts). This error should never occur as long as Transpore™ is used for the sample substrate and the High Voltage and Gain potentiometers are set properly during SPF initialization.

Error Reading DAS Card Output

A DAS card read error occurs when a data array containing reading data is not indexed

properly. Under normal conditions this should not occur because WinSPF controls the array indexing. However, if the error occurs the first time the software is started after installation, this error indicates that the board and software driver are probably mismatched.

The SPF-290 Analyzer can use one of two data acquisition boards. For those using Windows NT only the DAS-802 board can be used. For Windows '95 or Windows '98 either the DAS-802 or DAS-8/PGA-G2 data acquisition boards can be used. However, it is very unlikely that one can get to this point without causing other errors beforehand; while performing initialization for example.
Check the Hardware Setup to ensure that the proper data acquisition board has been selected.

Stage Position Error

This message indicates that while sending the X-Y stage to a new position in preparation for the next sample scan an error in the stage motion routine occurred. This could mean that the stage did not reach its new position in a prescribed time interval or that some obstruction occurred in the stage travel.

If the stage chatters loudly during a move, it usually indicates a mechanical obstruction. However, if the power was cycled to the stage controller, the motor controllers may lose their defined addresses. In this case instructions for the Monochromator or other stage axis may be interpreted incorrectly and the stage may move in the wrong direction. This will cause the stage to never reach the correct position, resulting in this error.

To correct the problem exit WinSPF and cycle the power to both the SPF-290 Analyzer and the stage controller. Then restart WinSPF at which time addresses will be reassigned.

Error Handling Excluded Scans

A list of included scans, those scans that are not excluded by the user, is stored in a memory array to be accessed by various software routines. This error occurs if this array is indexed incorrectly, usually by trying to load more data than the array can accept. This error should not occur under normal operation. However, potential exists for this error to occur if insufficient computer memory is available. This condition might occur for large numbers of sample scans.

Divide by Zero Error

If any number is divided by zero, it yields an infinite number. This produces a computer system error that can cause the computer to crash (lock up and not respond to input). WinSPF traps this

error preventing it from crashing the computer. One exception is during a sample scan. If the DAC board A-D output is zero, the software resets it to a count of 1 or 0.000305 volts. This is to prevent samples that are opaque at one wavelength but somewhat transmissive at others from halting the system operation. However, be aware that this produces a slight error.

In WinSPF calculations this should not occur provided the data acquisition board is functioning properly, the light source is operating and the light beam is not blocked.

However, on rare occasions, if a memory array is mishandled, such an error can occur in software. WinSPF traps this error so the computer will not crash

Overflow Error in Calculation

Computer languages operate on different data types, text, integers and fractional numbers. Within numbers there are several data types available to the programmer. If one expects calculations to yield small numbers one specifies that the calculations are done with a particular type of number. If the results are expected to yield large numbers, different data types are specified.

The programmer uses the most efficient data type; the one that uses the least memory. Under normal conditions and with proper testing the resultant calculation should not exceed the capacity of the specified data type. However, if the resultant calculation yields a result that exceeds the data type, this error occurs.

If this error occurs, please communicate with Optometrics so that corrective action can be taken. Please record the operating sequence at the time the error occurred.

Lamps Needs Replacement

During the system test, WinSPF checks the lamp output at 290 nm. If the system throughput is below 0.8 volts this message is displayed, indicating that the lamp needs replacement.

As the lamp is used the electrode surface is vaporized with the material usually condensing on the coolest surfaces, the envelope of the lamp. As the plated layer increases in thickness its absorbance increases thereby reducing the lamp output.

Therefore, even though the lamp is still operating, its output may be so degraded as to produce unreliable SPF predictions. Thus, the lamp should be replaced as described.

Function Called Incorrectly

This error should not normally occur in WinSPF. However, if it does occur, please contact Optometrics describing the conditions under which the error occurred.

File Not Found

This error occurs when WinSPF cannot locate the file name to load into the program. If using the file open dialog box always select a file rather than type a file name to avoid typing errors.

If this error occurs elsewhere in the program it indicates that a file that had been present at one time is no longer available to the operating system or WinSPF.

Data File is Corrupted

This error occurs when loading a data file from disk for review. The error indicates that the file contents are invalid. This most often occurs when users have reviewed the data file using a text editor and have inadvertently changed some data.

However, it can also occur if portions of the file are inadvertently overwritten by the operating system. If this error occurs please contact Optometrics with details.

Minimum Time Based Interval

The minimum sample interval is variable depending on other parameters in the setup file; the number of readings, reading interval and stage speed. The software calculates the minimum time interval based on these entries and the time it takes for various other SPF-290 operations.

DAS Driver not Installed

The data acquisition board uses a software device driver to communicate between the device hardware and WinSPF. If the proper driver is not loaded, improper instructions may be sent to the data acquisition board.

WinSPF automatically attempts to load the data acquisition device driver during startup. However, if the software cannot find the driver file at the usual location this error occurs.

Check the File Structure section to determine that the file exists where the software is expecting it.

DAS Board not Detected

The data acquisition board is installed in the SPF-290 computer. The board must have an address for WinSPF to pass instructions that can be interpreted by the board and processed.

WinSPF attempts to initialize the board at startup based on information stored in either the operating system registry or in an .ini file on the computer's hard disk.

If this error occurs, shut off the SPF-290 and SPF-290 computer power. Locate the data acquisition board and check the address settings as described in DAC Address Setup. Then restart the system and use the Hardware Setup to ensure that the correct address is being used and that the correct board is selected.

DAS Board Failed to Initialize

An error has occurred while WinSPF passed configuration instructions to the data acquisition board. There are five potential causes of this error.

- If the error occurs the first time the software is started after software installation or changes were made to the hardware configuration, there is a potential mismatch between the software driver and the data acquisition board. To correct the problem, go to hardware configuration and change the data acquisition board type.
- The DAC Address may be incorrect.
- If using the DAS-8/PGA-G2 data acquisition board, the .ini file could be corrupted. Again, because the board passed initialization the address is valid. However, some other data is invalid. Check the KMBDAS8.ini file for contents.
- If using the DAS-802 board, the installation could be incorrect or corrupted. Because the installation configuration is written to the operating system registry, diagnosis is beyond the scope of this manual. However, the best approach is to reinstall the driver carefully following the instructions. **Note, it is very important to uninstall the driver before a second installation attempt.**
- The data acquisition board is defective. Contact the factory for further information.

DAS Board and Driver Mismatched

The data acquisition board uses a software device driver to communicate between the device hardware and WinSPF. If the proper driver is not loaded, improper instructions may be sent to the data acquisition board.

WinSPF automatically attempts to load the data acquisition device driver during startup using information in the SPF.ini file, the KMBDAS8.ini file or the system registry. If any of these locations contain faulty data, the incorrect device driver might be loaded.

Check the board model that is installed in the SPF-290 computer and ensure that the **Hardware Setup** indicates the correct board has been selected. Saving the hardware setup will rewrite the setting to various locations. Try the software again. If the problem persists, contact Optometrics for more details.

Gain or Voltage too High

During SPF initialization WinSPF sends the Monochromator to the peak wavelength and the user adjusts the high voltage and gain controls so the system throughput is set within a valid range. If the SPF-290 was allowed to warm up for 15 – 30 minutes before use, this adjustment should be sufficient.

However, if the SPF-290 is used immediately upon startup, the lamp output will increase for a few minutes. If the increase is sufficient, the data acquisition board's A-D converter can be saturated, producing erroneous results. Therefore, WinSPF checks the system output prior to each set of readings. If the signal is too large, the user must reset the high voltage and gain levels before further measurements can be taken.

The high voltage acts as a course signal level adjustment while the gain potentiometer allows finer control. Once a reasonable setting has been achieved, lock the high voltage potentiometer and make future adjustments with the gain potentiometer.

Monochromator Wavelength Error

An error occurred while the Monochromator was being instructed to move to the peak wavelength for the signal level check. The error can only be caused by a failure of the Monochromator stepper controller to accept a command or notify WinSPF that the motor has stopped at the correct position.

Although unlikely, the serial communication between the SPF-290 Analyzer and the SPF computer might have failed. However, this can be determined by restarting WinSPF. The serial port is routinely verified at software startup.

Failed to Find Zero Order

For the wavelength of the Monochromator to be accurately set the software searches for the zero wavelength position by scanning across zero order and collecting data representing the intensity at various motor positions. The software then scans the intensity profile data, using characteristics of the profile and linear interpolation to determine the location of the peak. Once the peak location is known, the Monochromator is moved to this position where its controller's counter is set to zero. Thus, the controller's zero position directly corresponds to the Monochromator's zero wavelength position.

When this message is displayed an error has occurred in the initialization routine. There are three potential causes of this failure:

- The data acquisition board is not operating correctly. This can be due to incorrect addressing, software device driver mismatch or improper board configuration. However, this type of problem should only occur during original setup or if the Hardware Setup has been changed.
- On very rare occasions the motor and controller fail to find the "home" position correctly. The search criteria then becomes invalid causing this error message to occur. Corrective action is to attempt the procedure again.
- Communications between the SPF-290 and the Monochromator motor controller has been interrupted. Therefore, instructions to the motor controller are not enacted. Restart WinSPF and be certain no communications errors occur.

Number of Scans Too Large

The maximum number of sample scans allowed is 12. When adding scans, the maximum number of additional scans is the difference between 12 and the number of scans already taken. Thus, if 6 scans have been taken, the maximum additional allowed scans are 6.

Data is Corrupted

Invalid data has been detected when a data file was loaded for review. The file contents may have been damaged. There is no recovery for this error. The file cannot be corrected because its true contents are unknown.

Drive is Unavailable

The hard drive or diskette is currently inaccessible for disk operations.

Insert Diskette

A diskette is not installed in the floppy drive. Insert a formatted diskette and try again.

Hard Drive Error

An error occurred while writing data to the system's hard disk.

Disk is Full

The hard disk is full. Therefore, the current file cannot be stored to disk. Remove unused files using Windows Explorer and try again.

Illegal File Name

The file name specified includes characters that are not valid. All keyboard characters except / \ < > * : ? and | are valid.

Path Not Found

The path specified in the operation does not exist. Use Windows Explorer to add the folder and try again.

File Access Denied

The user does not have sufficient rights to access the file.

File Already Open

The requested file is already open.

Attempted Read Beyond End

A special character is attached to the end of a file. Routines that load data from a file cycle through the entries until the special character is input. The software then stops attempting to read from the file and proceeds with other operations.

However, if the file is damaged and the end of file character is removed, this error can occur.

Error Reading Data From File

An error occurred while reading data from a file. Corrupted file contents or some glitch in the operating system can cause such errors. Try reading the file again. If failure continues, try another file. If successful, indications are that the prior file was defective.

Error Saving Data to File

An error occurred while saving data to the SPF-290 computer's hard disk. Try saving again. If

a duplicate file error occurs, remove the suspect file using Windows Explorer and try saving the file again.

Appendix A

Year 2000

Because WinSPF does not use date math in any of its calculations, it is not susceptible to the Y2K "bug" that is so much in the news. However, WinSPF formats all dates and times according to the **Regional Settings** in Windows. When the default system date and time are displayed in the **Sample ID** and **Test Log** forms, they are displayed according to your settings. Likewise, if you enter the year as a two-digit value and the **Regional Settings** are configured for a four-digit value, when the date field loses focus, WinSPF reformats the date to your settings.

In some cases the Windows **Regional Settings** use two-digit date codes while for others four-digit date codes are used. If you wish to use four-digit date codes and your **Regional Settings** are set for two-digit, simply change the selection in the **Short Date Style** field in the **Regional Settings** under the **Date** tab. If one of the selections does not include four 'y' symbols (yyyy), simply edit the desired setting and add two 'y's. The date will then be formatted to four-digit years.

The other part of the Y2K "bug" is that the computer in which WinSPF is installed may not switch dates appropriately on December 31, 1999. This is a function of the computer's BIOS and WinSPF has no way of controlling the BIOS. Because WinSPF uses the system date for its date coded operations, be sure to check the system date prior to using any software on January 1, 2000 or thereafter.

Appendix B

Equations

WinSPF performs several calculations in the process of providing a SPF report. The SPF calculation is well known from literature and is included here for reference. This section includes equations that will assist the user in understanding some of the data produced by the SPF.
This section is divided into three sub-sections.

- The first reviews the basic data acquisition techniques used in the SPF-290 software and hardware, and the equations used to convert raw data into meaningful units.
- The second section describes the equations used for data displayed in the MPF (monochromatic protection factor) report. This is the display that shows MPF values in tabular and graphical form. The tabular data are shown in the section labeled **Data Window**.
- The third section describes calculations that are displayed in the **SPF Data** report.

Data Acquisition

Those familiar with data acquisition systems recognize that A-D (analog-to-digital) converters are used to convert an analog voltage or current output from a detector or transducer into a form that computers can read and process. Thus, an A-D converter takes a snapshot of the signal at some point in time and converts that into a computer word. At some later time we may take another snapshot of the detector output to see if the readings is stable or has changed. For the data acquisition board used in the SPF-290 the conversion is completed in < 35μsec. Thus, many snapshot readings can be acquired in a very short time span.

The data acquisition board in the SPF-290 has a 12-bit A-D. This means that the maximum reading attainable is 4096. (This unitless number is often referred to as counts.) This number represents the full-scale reading of the A-D with all other values being proportional to the full-scale voltage. Thus, if we have a 10-volt A-D and we acquire a reading of 2040, we know it represents a detector output of 4.980 volts. Recognize that the "counts" are integers. Thus, the voltage that we can resolve is one count. In the case of a 10-volt, 12-bit A-D, one count represents .002441 volts.

The SPF-290 data acquisition board has gain controls to provide the best possible resolution at

different signal levels. When the SPF-290 goes to a wavelength in preparation for a reading, the software samples the signal by taking one reading. If the A-D output is less than 1000 counts, the board gain is increased unless it is already at its maximum. Additionally, the software checks if the sample reading is > 4000 counts. If so, the gain is decreased. The gain control is not continuous and can assume values of 1, 2, 4 or 8. This means that the full-scale readings can be 10, 5, 2.5 and 1.25 volts respectively providing resolutions of .00244, .00122, .000611, and .000305 volts.

As readings are taken, the resultant A-D "counts" are stored in a buffer. WinSPF sequentially reads the buffer's contents, converts the "counts" into a voltage and stores the results in an array. The equation used for the conversion is:

$$v_\lambda = \frac{counts * 10}{4096 * gain}$$

Equation 1

The "voltage" array is then sequentially read and an average voltage calculated as follows:

$$\overline{v_\lambda} = \sum_{i=1}^{n} \frac{(v_\lambda)i}{n}$$

Equation 2

where n = the number of readings taken after the gain has been set.

The above procedure is identical whether a reference scan or sample scan is being acquired.

MPF Calculations

The voltage readings for the reference scans are stored in an array for various calculations and display. However, the sample scan is never displayed as a voltage but as a Monochromatic Protection Factor (MPF) displayed in tabular form in the Data Window and graphically while collecting scan data. Monochromatic Protection Factor (MPF) is defined as the reciprocal of the sample transmittance. Transmittance of a sample is given by:

$$T_\lambda = \frac{\overline{S_\lambda}}{R_\lambda}$$

Equation 3

where T_λ = Transmittance at wavelength λ

S_λ = Scan reading in volts at wavelength λ, and

R_λ = Reference scan in volts at wavelength λ

Thus, MPF is given by:

$$MPF_\lambda = \frac{1}{T_\lambda}$$

Equation 4

Or

$$MPF_\lambda = \frac{\overline{R_\lambda}}{S_\lambda}$$

Equation 5

SPF Report Equations

This section contains the equations whose results are displayed in the SPF Data display. The equations shown are calculated for each scan in the sample run. The various results are averaged to produce the value displayed on the report. The standard deviation is then calculated for the scans that make up the sample.

We begin by reviewing the tabular data displayed in the SPF Data window. We have three columns of data that include wavelength (lambda), mean MPF (AvgMPF) and standard deviation (STDV)

The mean MPF is given by:

$$\overline{MPF_\lambda} = \frac{\sum_{i=1}^{N} (MPF_\lambda)i}{N}$$

Equation 6

where: MPF_λ = the value calculated by the equation # 4 or # 5

N = the number of sample scans.

The classical standard deviation calculation used for MPF STDV is given by:

$$\sigma_{mpf} = \sqrt{\frac{\sum MPF_\lambda^{\,2} - N * \overline{MPF_\lambda}^{\,2}}{N-1}}$$

Equation 7

where: N = the number of sample scans.

The value for Sunscreen Protection Factor (SPF) is given by the following equation:

$$SPF = \frac{\sum_{290}^{400} E_\lambda B_\lambda}{\sum_{290}^{400} \frac{E_\lambda B_\lambda}{MPF_\lambda}}$$

Equation 8

where: E_λ = Spectral irradiance of terrestrial sunlight under controlled conditions,

and B_λ = Erythemal effectiveness (CIE).

The user has two choices for the standard deviation calculation for SPF. The classical choice is given by:

$$\sigma_{spf} = \sqrt{\frac{\sum SPF_s - N * \overline{SPF}^2}{N-1}}$$

Equation 9

where: SPF_s = Individual scan SPF value, and

N = number of sample scans.

The second method available for SPF standard deviation is that derived from that promoted by B.L. Diffey in J. of Cosmet. Chem., 40, 127-133 (May/June 1989). It is given by:

$$\sigma_{Diffey} = SPF^2 \frac{\sqrt{\sum \frac{E_\lambda B_\lambda \sigma(MPF_\lambda)}{MPF_\lambda^2}}}{\sum E_\lambda B_\lambda}$$

Equation 10

where: $\sigma(MPF_\lambda)$ = value calculated in Equation # 7

A form of Equation # 9 is used for all other displayed standard deviations where the measured values are substituted for SPF.

The UVA/UVB ratio is given by:

$$UVA/UVB = \frac{\int_{320}^{400} Log_{10} MPF_\lambda / \int_{320}^{400} d\lambda}{\int_{290}^{320} Log_{10} MPF_\lambda / \int_{290}^{320} d\lambda}$$

Equation 11

where: $d\lambda$ = wavelength interval, which is 5nm for the SPF-290

The UVA protection factor (UVA PF) is given by the following:

$$PF_{uva} = \frac{\sum_{i=1}^{17}(MPF_\lambda)i}{17}$$

Equation 12

where: 17 = number of 5nm wavelength intervals in the UVA spectral region (λ320 - λ400).

The erythemal UVA protection factor is computed using the following equation:

$$PF_{Euva} = \frac{\sum_{320}^{400} E_\lambda B_\lambda}{\sum_{320}^{400} \frac{E_\lambda B_\lambda}{MPF_\lambda}}$$

Equation 13

The critical wavelength is the wavelength at which the integrated absorbtion from 290nm is 90% of the integrated absorbtion from 290 – 400nm. It can be expressed as the wavelength at which the following is true.

$$0.9 = \frac{\int_{290}^{\lambda_{crit}} Log_{10} MPF_\lambda}{\int_{290}^{400} Log_{10} MPF_\lambda}$$

Equation 14

Although MPF values are taken every 5nm, linear interpolation is used to compute fractional parts of wavelength intervals.

The curve area, also called cumulative absorbance, is the given by:

$$A = \int_{290}^{400} Log_{10} MPF_\lambda$$

Equation 15

The star rating is based on the average UVA/UVB ratio. A different rating is given to a range of values as shown below.

UVA/UVB Ratio	Star Rating
<= 0.199	0
0.200 – 0.399	1
0.400 – 0.599	2
0.600 – 0.799	3
>=0.800	4

The assay mode provides two options for "classical" standard deviation calculation, labeled **Standard deviation (samples)** and **Standard Deviation (scans)**. The same equation is used for both calculations and is of the same form as Equation # 9, substituting for SPF. However, **Standard Deviation (samples)** uses the number of sample runs in the assay. For **Standard Deviation (scans)**, the deviation is based on the total number of sample scans in the assay.

Appendix C

Editing Spectra

There are two spectra files that are used in the SPF calculation, which provide weighting factors for the spectral data acquired during the measurement run. The spectra include:

- That of extraterrestrial solar irradiance at a prescribed global location, under very specific conditions, and
- The effectiveness of the sun to cause erythema on a particular skin type.

The spectra included with WinSPF is for latitude 40 Deg.N, solar zenith angle of 20 Deg. and an ozone thickness of 0.305 and is derived from published data. The erythema effectiveness spectra used in WinSPF conforms to CIE (CIE S 007/E-1998). WinSPF enables the user to modify these spectra to suit particular needs.

The **Spectra** menu provides access to the various spectra manipulation features. Choosing either **Solar** or **Erythemal** opens the menu shown in the following figure. If spectra are already in memory (loaded automatically when loading a setup file), the user may choose just to **Display** the current spectra for review or choose **Edit**, which displays the spectra and opens controls so the spectra can be edited. If one chooses, one can also **Load** spectra before displaying and editing. The **Combined Response** menu choice displays the product of the Solar irradiance spectra and the Erythemal effectiveness spectra.

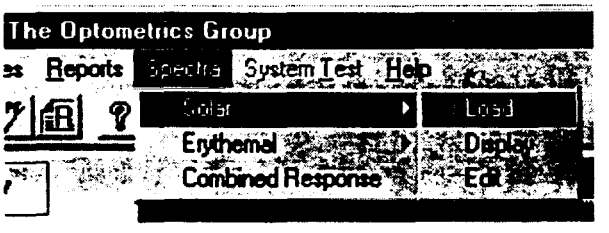


Figure 47 - The Spectra Menu

When choosing to edit the spectra, the spectra data are displayed graphically and in tabular form. As shown in the following figure, spectra editing controls are also displayed at the bottom of the **Data Window**. One cannot change the wavelengths of the spectra, but one can change the value used at that wavelength.

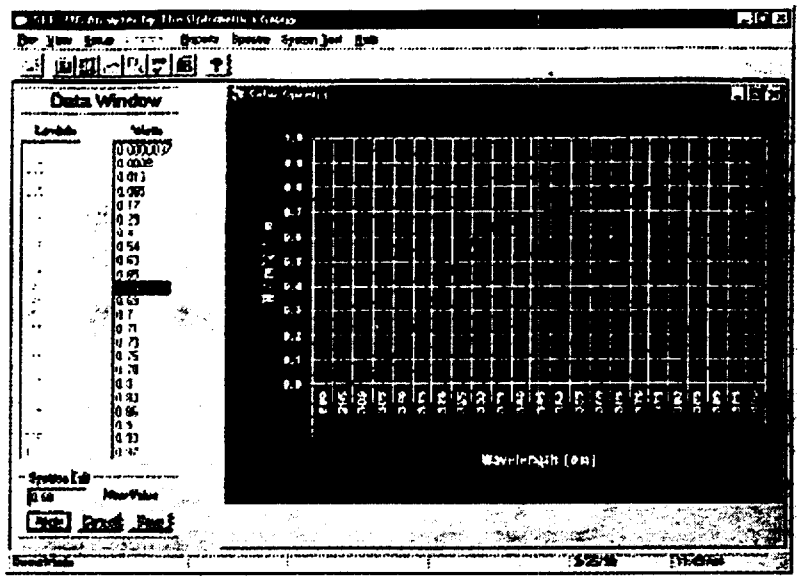


Figure 48 - Spectra Editing Controls displayed in the Data Window

To make a change, select a value to change by pointing the mouse and clicking the left button. The value is highlighted and displayed in the box labeled **New Value**. Change the number in the **New Value** text box using typical Windows techniques, and select **Apply**. The change will be made in both the table and the graph but will not be saved. Make additional changes until satisfied and then **Save** the changes. Selecting **Save** opens the file dialog box showing the existing files in the **[App Path]\spectra** directory. The user can enter a new name for the spectra and save it to disk.

Revised files can be used by selecting them when editing the setup files.

Once a file has been created, it can be routinely used while collecting data by loading it as described in sample setup parameters.

intensity exiting the sample. Light intensity is usually proportional to the photocurrent output from a detector.

Scan

A sequence of measurements of a reference or a sample at 5nm intervals over the wavelength range from 290nm to 400nm. A group of scans taken at different locations on the sample comprise a Run.

Standard Deviation

The standard deviation is a measure of the dispersion of data from the mean or average value of the data.

Sunscreen Protection Factor (SPF)

SPF is an indicator of the UVA/UVB protection property of a sunscreen product, calculated from MPF measurements, solar irradiance and erythemal constants.

Unity UVA Protection Factor

The UVA Protection Factor is weighted by the solar irradiance.

UVA Protection Factor

The summations of MPF readings over the wavelength range from 320nm to 400nm.

UVA/UVB Ratio

This ratio is used as a measure of the relative absorbance of the sample in the UVA and UVB ranges. The UVA wavelength range is from 320 nm to 400 nm while UVB is from 290 nm to 320 nm. Thus, we have the area per unit wavelength of the absorbance curve from 320 nm to 400 nm divided by the area per unit wavelength of the absorbance curve from 290 nm to 320 nm.

Wavelength

In general, wavelength is the distance between two points that are in phase in successive cycles of a periodic phenomenon. In the SPF-290 wavelength (often referred to by its symbol name lambda, λ) is the measure of the "color" of light. The unit of measure is nm (10^9 meters).